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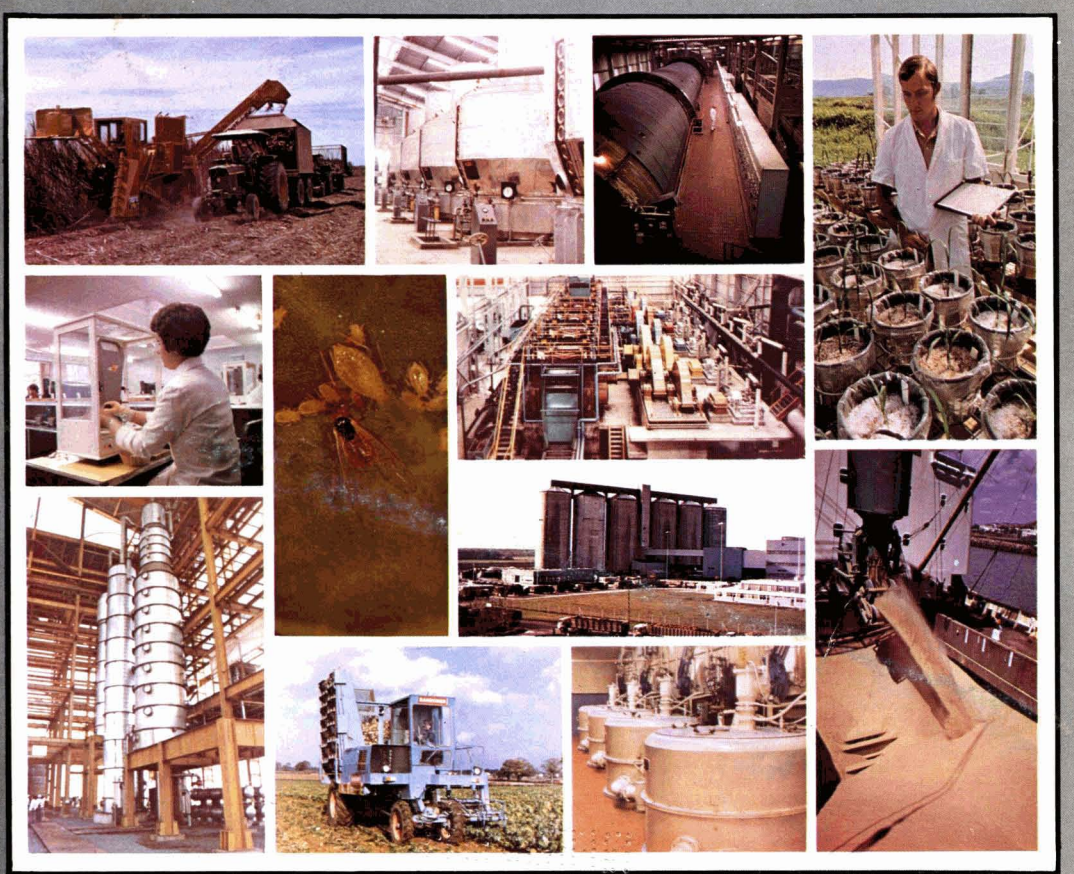

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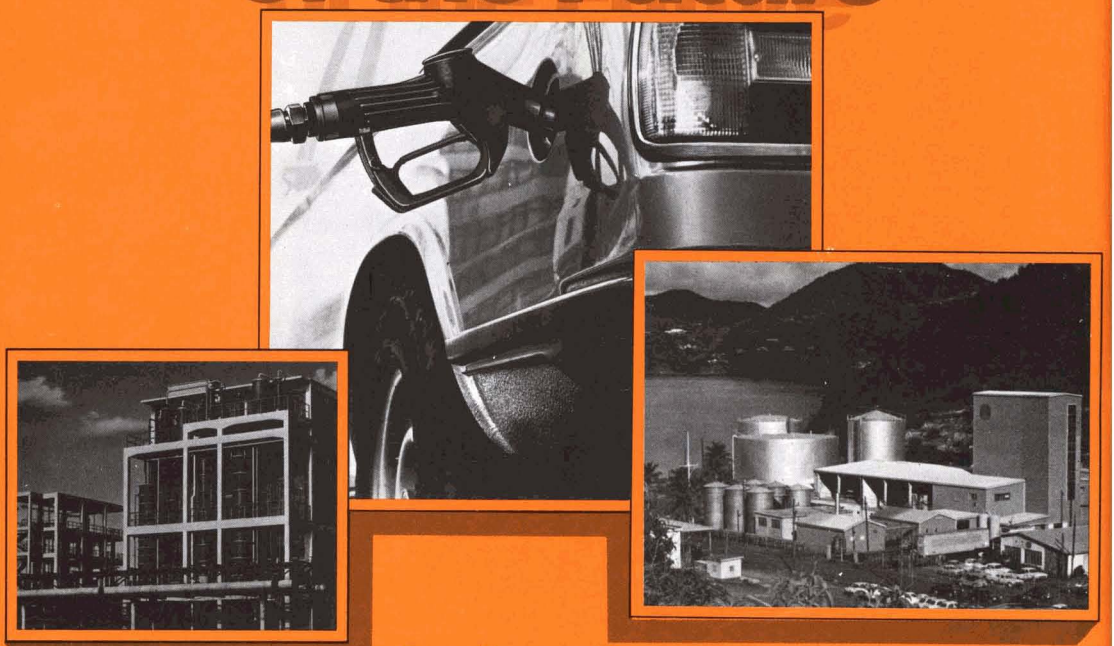

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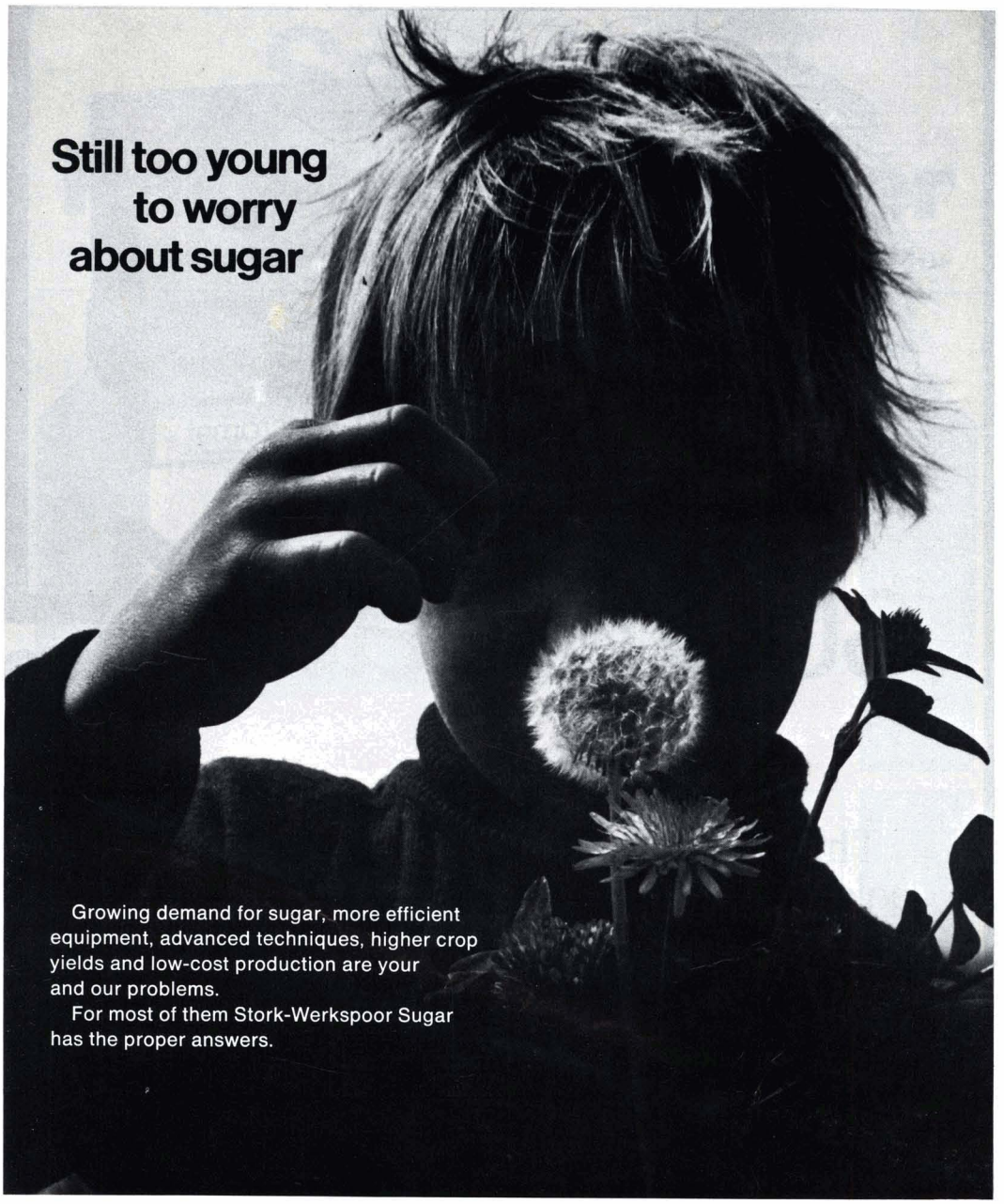

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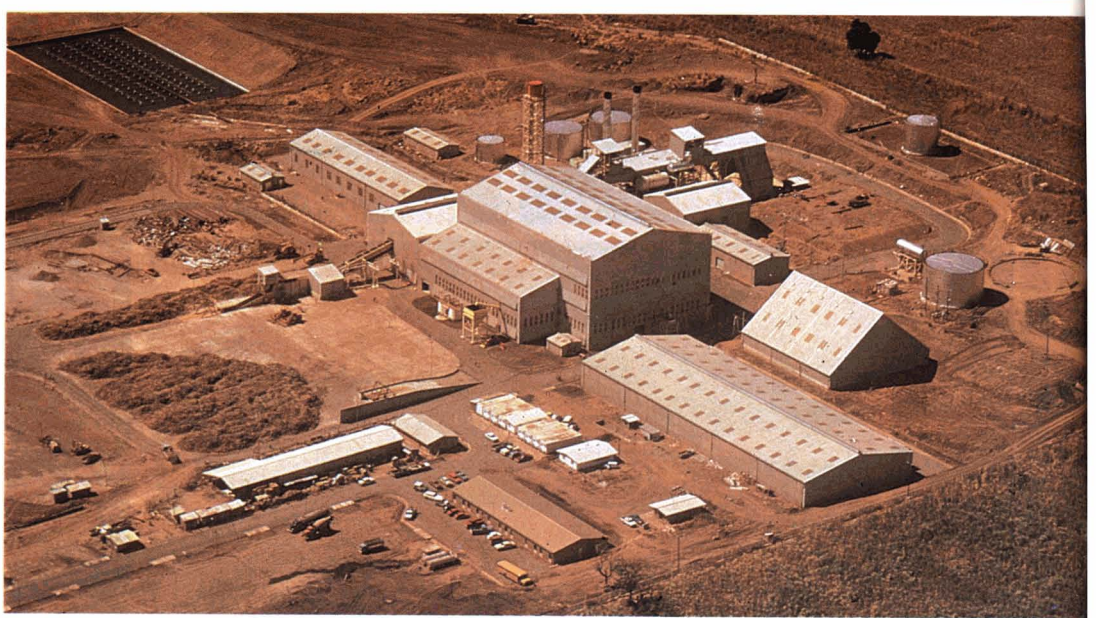

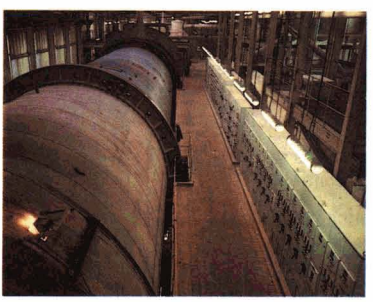

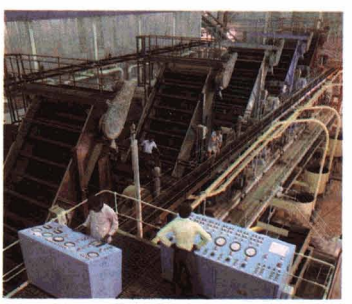

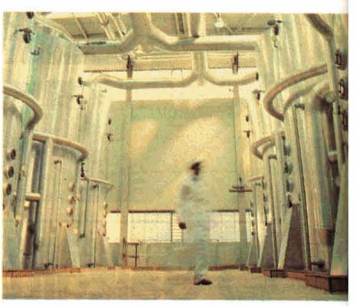

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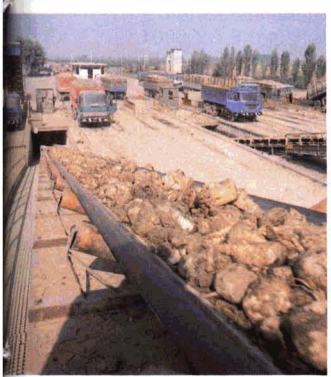

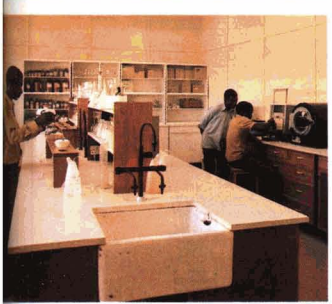

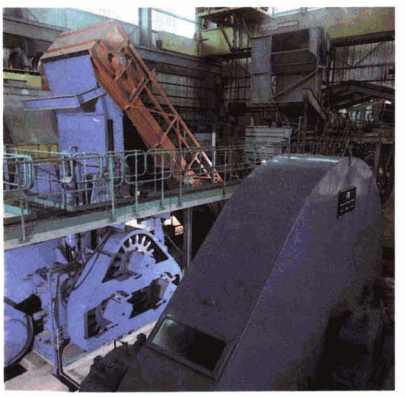

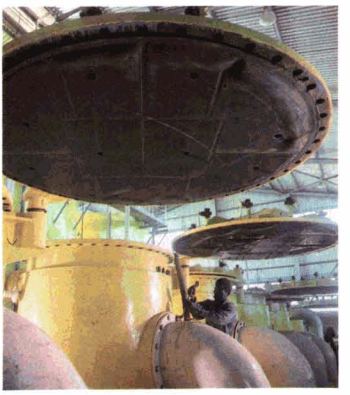

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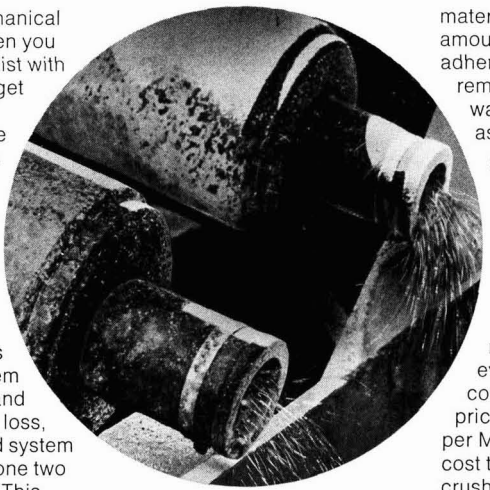

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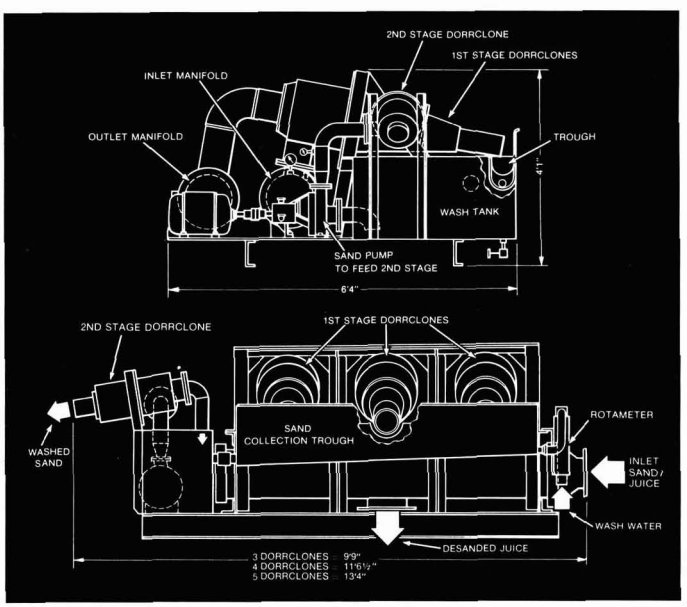

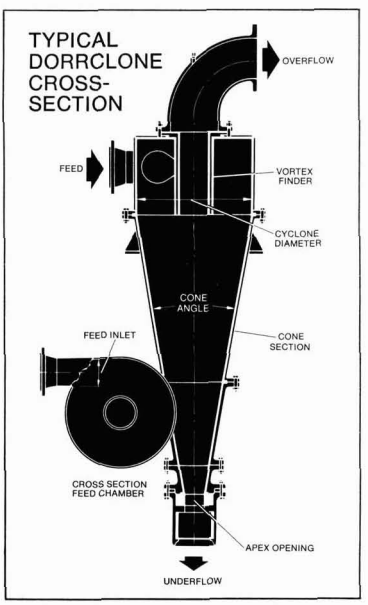

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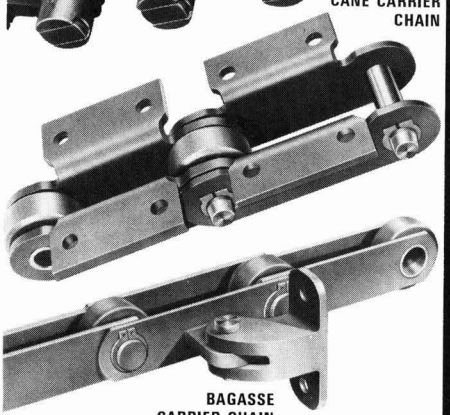

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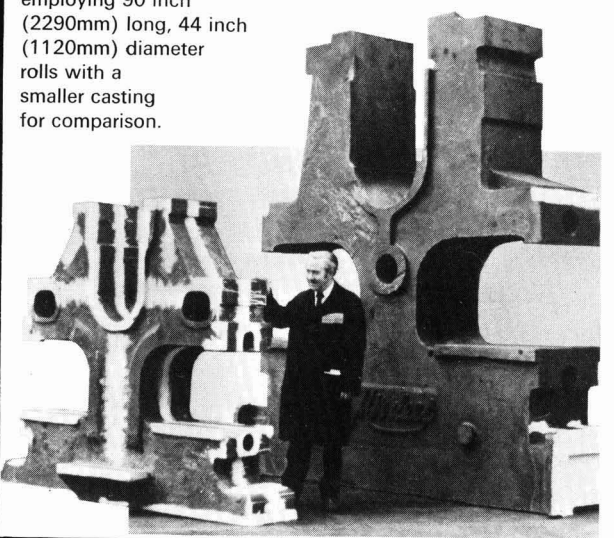

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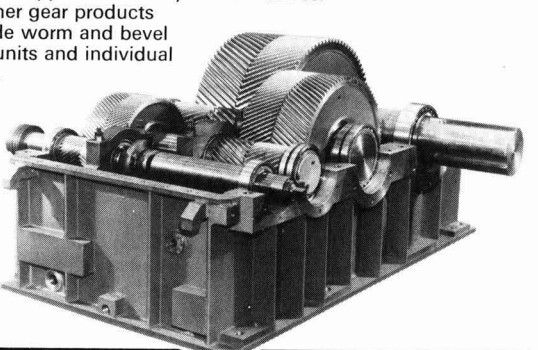

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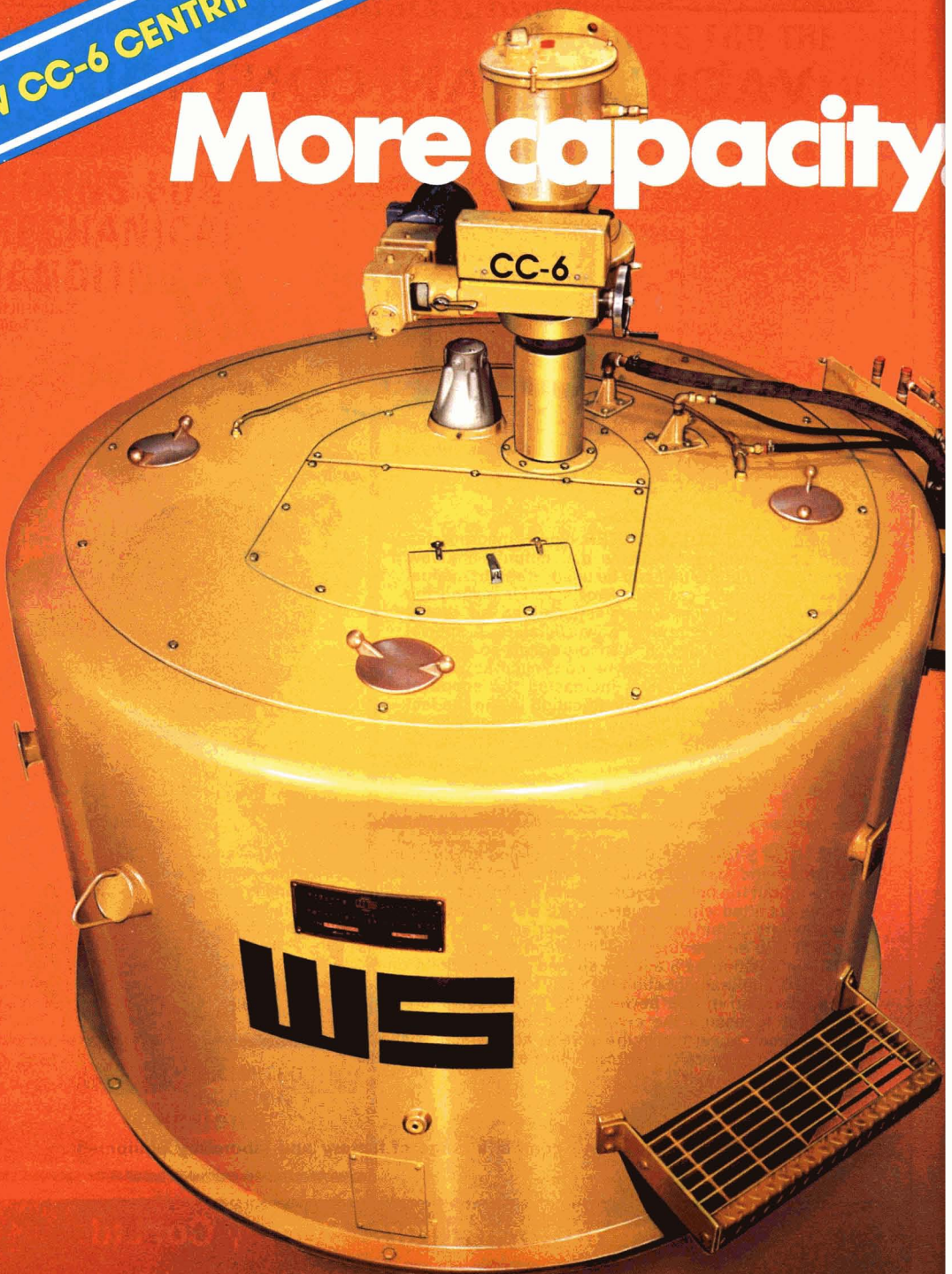

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NOTES AND COMMENTS

Sugar production and price cycles

High prices for sugar have in the past encouraged production increases which have led to surpluses and low prices; production has then stagnated until consumption has overtaken it and prices risen again. Such cycles have been reckoned to occur at seven-year intervals. Recent studies[1] indicate that this time scale will in the future be shortened to about 5 years.

The major reason is that the future expansion rate of production is likely to be lower than in the past. HFCS is making serious inroads into the sweetener market; the cost of finance is very high, contributing significantly to elevated cost of production and so requiring higher sugar prices before investment is made in new plantations and factories. More importantly, however, the structure of the outlets available to exporters has changed. The size of special export markets (e.g. the US and UK) has shrunk and the size of the free market has increased accordingly to about 75% of the world's exportable sugar. Wide price fluctuation and strong competition make risk greater and investment into sugar production for export less likely.

Thus, excess supplies in the future are not likely to be so large and the periods of excess relatively short-lived. By implication, sugar prices in the future will not reach the lows of the past and fluctuations will be more violent. In the view of *World Sugar Journal*, different mechanisms will have to be developed for the future management of supplies on the free market.

The future for US sugar imports[2]

The future import potential of the US will depend on two factors, namely the growth of total sweeteners demand and the availability of domestic supplies of both sucrose and corn sweeteners, especially HFCS. The uncontrolled high sugar prices of 1974/75 gave an irresistable impetus to the building of many high fructose corn syrup plants, largely by companies already in the wet milling business. With relatively low-cost corn as raw material and soaring sugar prices, HFCS producers enjoyed a boom, built vast plant capacity – far in excess of market needs at that time – and made heavy inroads into the sucrose market. The HFCS share of per caput sweetener demand increased from about 1% in 1970 to 11% in 1979. Shipments in that year totalled 1.75 million short tons, dry basis, and are expected to grow to more than 2 million tons in 1980.

The second generation HFCS, containing 55% levulose, was commercially introduced in 1978 and accelerated demand. The major break-through for HFCS came in 1980 with the approval by Coca-Cola Company (followed by other soft drink manufacturers) of 50% replacement of refined sugar in its product by second generation HFCS; it seems to be only a matter of time before 100% replacement is approved. The domestic HFCS industry does not have the capacity to supply this new market fully in 1980 and the new demand for an additional 1.5 million tons may not be fully met until 1982 or later. Trade sources estimate that existing installed plant capacity and planned expansion in new plants should have a combined output of 3.8 – 4.0 million tons by 1985. As bottlers replace sugar with HFCS, the demand for sugar will decline.

Over the past few years there has been a major shake-out in the US sugar industry. Against 72 beet sugar factories in 1950 the number had declined to 44 in 1979 and, with 12 new factories built during the same period, means that 40 ceased operations. In a recent report, the USDA said that, for the near future, closures of cane sugar and beet sugar factories can be expected to continue but at a much slower rate than during recent years. Closures are expected to be generally confined to the older, smaller, less efficient cane sugar factories and to beet sugar factories where beet competes for land with other crops. Despite current high sugar prices, construction of new facilities is not expected but present prices will allow inefficient plants to continue operation. Present indications are that US sugar production will not be reduced drastically as most inefficient facilities have already closed.

Hence foreign suppliers will have to bear the brunt of the adjustment process. Sugar imports are expected to decline gradually from 5 million tons in 1979 to slightly more than 3 million tons in 1985. This means that sugar exporters, particularly from Latin America, will either have to look for new outlets or find new uses for sugar cane.

World sugar prices

The London Daily Price of raw sugar started the month of June at £330 per tonne but slid to £285 by June 11, recovering to £330 by June 16 and thereafter fluctuating sharply between £305 and £334, to end the month at £320. White sugar prices followed a similar pattern but with less marked swings; the LDP(W) started at £350 per tonne and slid to £310, recovering to £348 and thereafter varying between £330 and £347.

E. D. & F. Man note[3]: "For the moment two main factors influence the market: the current discount physical position and the predicted tightness of the end of the year. Combined, they probably justify a marking time of values in the short term, although the market is probably incapable of this, bearing in mind the strong speculative interest".

The Commodities correspondent of *The Times* considers that fundamentals do not support an inflated sugar price[4]; however, "harvest and trading conditions over the rest of 1980 suggest that there will still be upward pressure on the price, so it is quite possible that selling by profit-takers, foreseen on the charts, will be followed by a recovery, extending into the winter."

Mexico sugar industry re-organization[5]

The Mexican Government has instructed the Director of the National Sugar Industry Commission to reorganize completely the entire sugar industry, according to a USDA report. The recent upward revisions in the price of sugar represent the first step in placing the industry back on a solid financial basis. The Government intends to phase out gradually its annual sugar subsidy through the establishment of prices which more accurately reflect the true cost of production. The privately-owned sugar factories that have reverted to the Government

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1 *World Sugar J.*, 1980, **2**, (12), 4-5.
2 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 303-306.
3 *The Sugar Situation*, 1980, (349).
4 June 16, 1980.
5 F. O. Licht, *International Sugar Rpt.*, 1980, **112**, 296-197.

are to be completely renovated, along with those mills that are still in private hands. The President has urged an earlier time schedule for the start of construction of the five new sugar factories planned for south-east Mexico.

On January 2 a decree was published in the *Diario Oficial* which established a new system for calculating the price paid to growers for sugar cane delivered to sugar factories. The major impact of the new decree will be an immediate boost to grower incomes. The pricing scheme has a built-in adjustment mechanism to assure growers that their income will not be eroded by inflation. Growers are expected to react to the decree by expanding their new plantings, which should assure Mexico of a growing supply of raw material and, it is hoped, a larger sugar outturn.

Brazil and the 1980/81 sugar balance[1]

With price levels at the beginning of 1980 reflecting a tight supply situation, the ISO was led to employ the mechanisms at its disposal to contain prices within the range of 11 – 21 cents/lb. In a short period of time, all these were exhausted by the suspension of quotas and liberation of stock reserves. These reserves, supposedly 2 million tonnes, compensated for the decreased output of around 1.5 million tonnes from several important producers of raw sugar, namely Cuba, Dominican Republic, Peru and Thailand, while covering the important needs of Mexico and the USSR.

Market stability remains precarious, however. Preliminary statistical studies of the 1980/81 campaign show a continuing tightness. The fear of potential disruption of supply could upset the delicate balance which now exists and a new tension on the market could result from purchases in anticipation of future deficits. If such precautionary purchases do indeed take place there is a risk that we could see a disruption of the flow of supplies as early as the end of 1980.

The 1980/81 harvest will therefore have an important influence during coming months; it will be the key element of price movements. Given a planted area essentially unchanged from last year and based on average yields, the EEC could be susceptible to a drop in production of about 1.5 million tonnes; after four consecutive records it is for the moment at least more prudent to base one's ideas on average yield rather than recent results. This fall might be compensated by better harvests in non-EEC countries, but numerous factors can intervene between sowing and harvesting time.

India poses a problem in both production and consumption estimates, while Australia, the Philippines, Thailand and Argentina could probably increase their output to add a total of 1,000,000 tonnes to the market. Both Cuba and the Dominican Republic harvests were seriously affected by rust disease. It is unlikely that damage caused by rust could be cured from one harvest to the next so that improved crops cannot be expected from these two countries. South Africa is suffering from a serious drought which has caused a 20% reduction in its crop, i.e. 400,000 tonnes, and Mauritius, buffeted by several typhoons, will see its crop diminished by about 200,000 tonnes.

The unknown element is Brazil; this country has been involved with a domestic alcohol program for several years and the Government has demonstrated its support of the program for production of alcohol for automotive fuel. The question is whether higher price levels will induce Brazil to reduce its commitment to the alcohol program in favour of producing more sugar and increasing its exports. Almost half of Brazil's distilleries are attached to sugar factories, which permits delaying this decision until the proverbial last moment. Brazil could divert up to 2 million tonnes of sugar to the world market from its alcohol program and this country's policy will play a dominant role in determining the ultimate production/consumption deficit for the 1980/81 season.

EEC sugar prices, 1980/81[2]

Following representations from some member governments, the Common Market Agriculture Ministers have agreed to increase the margin for beet processors for the 1980/81 season by 2.5% over the figures indicated at the beginning of June[3]. The basic white sugar target price thus becomes 455.5 e.c.u. per tonne while the intervention price is 432.7 e.c.u. per tonne. The effective minimum price to consumers, taking into consideration the storage fee, has been increased to 461.6 e.c.u. per tonne. This, of course, does not affect the price of sugar beet delivered within the A quota, which remains at the 33.1 e.c.u. per tonne agreed at the beginning of June.

The regulation covering the five seasons up to 1979/80 specified that up to 10% of quota sugar had to be carried forward from one season to the next in order to ensure orderly marketing arrangements. The regulations, however, did not permit this quantity to be carried forward into the new regime. As the old regime has been extended for a further season it has been agreed that the commitment to carry forward the quota sugar is to continue into 1980/81.

HFCS production quotas have been granted on the basis of existing production levels. It has now been agreed that consideration will be given to granting production quotas to those companies which will be producing the sweetener in 1980/81 but are not yet on stream.

European sugar beet area

F. O. Licht GmbH has recently published its third estimate of the areas sown to beet this year for the 1980/81 campaign[4]. The total is now set at 7,770,000 hectares, down from the 7,855,000 ha of the second estimate and only 1.38% above the revised figure for the 1979/80 crop area. The figure for the EEC is now set a further 17,000 ha higher, at 1,798,000 ha vs. 1,766,000 ha, and almost all the change is due to a 15,000 ha higher estimate in the French beet area.

An increase from 137,000 to 160,000 ha had earlier been expected in the Yugoslavian beet area but the latest figure shows a fall to only 127,000 ha. Similarly, Turkey had been expected to raise its crop area from 270,000 to 299,000 ha, but the revised figure shows no change from 1979. The beet area in Greece, originally expected to have been almost the same, at 45,000 ha, has been cut by almost one-third and is now set at 31,000 ha. In East Europe, the total area is now set at 5,214,000 ha against the second estimate of 5,240,000 ha and a 1979 area of 5,139,000 ha. The changes are largely the result of a 5000 ha drop in the expected Bulgarian area and 20,000 ha in the USSR.

Bolivia sugar exports[5]. – Exports from Bolivia rose to 126,524 tonnes, raw value, in 1979 from 77,816 tonnes in 1978. Destinations were Argentina (2060 tonnes), Chile (46,681 tonnes), Syria (12,701 tonnes) and the USA (65,082 tonnes).

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1 *Sucres et Denrées*, May 5, 1980.
2 C. Czarnikow Ltd., *Sugar Review*, 1980, (1497), 121.
3 *I.S.J.*, 1980, **82**, 197.
4 *International Sugar Rpt.*, 1980, **112**, 329.
5 *I.S.O. Stat. Bull.*, 1980, **39**, (4), 20.

The application of computers and electronics to process control in Thames Refinery

By J. A. FITZPATRICK
(Tate & Lyle Refineries Ltd., London, England)

Introduction

There are two computers in Thames Refinery dedicated to process operations. The first, called the process computer, was installed in 1970 and the second, called the recovery computer, was installed in 1979. Both computer systems are used to control selected processes and to transmit information relating to process operation between key locations in the refinery.

The process computer system is considered to be fully developed. It has been operating successfully for ten years and many of the programs have not been altered for several years. However, the system electronics and programs are frequently altered as changes take place in the refinery. The recovery computer system has been operating for one year and more programs have to be added before this system can be considered fully developed. Both systems are kept operating continuously seven days a week, the refinery shutting only four times a year.

Process computer system

The process computer is principally a rate controller to maintain the entire process, from raw sugar intake to melt up to fine liquor into the white sugar pans, at the same rate of throughput. The computer controls include the proportioning of syrup in raw magma, affination machines starts, affination wash and spin times, raw melter dosing, raw liquor Brixing, return liquors flow, milk of lime flow, Sweetland presses starts and fine liquor flows. The set-points for all processes are under control of the shift manager and the required values are entered into the computer using a conventional terminal keyboard.

All processes controlled by the computer also have "stand-by" controls. These automatically take over in the event of a computer failure, a failure of the computer-process interface or an electrical power failure. In the ten years this system has been in operation, there have been several power failures and three computer failures but the interface has been trouble-free. Control can also be changed from computer to "stand-by" by operating a push button in the computer room. This is the only means of changing controls. All computer controls have been designed to take over instantly from "stand-by" controls at any time without any kind of preparation.

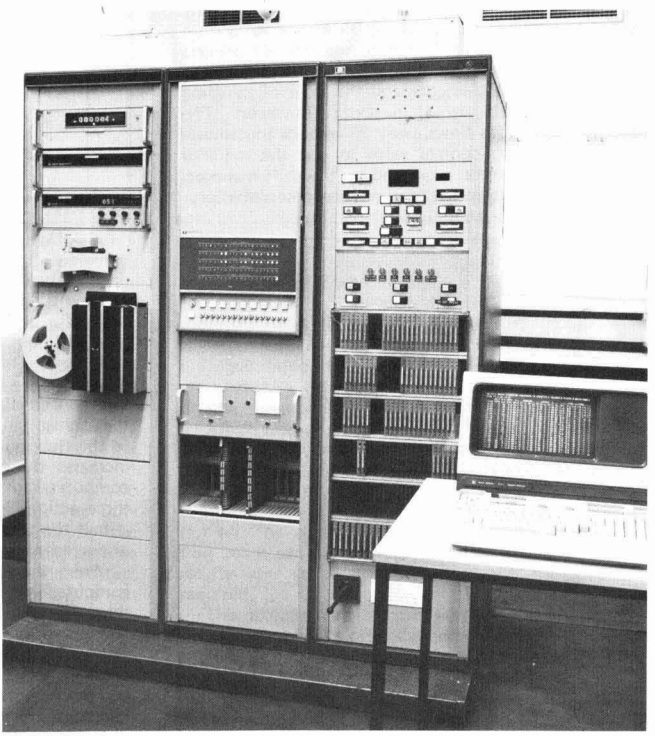
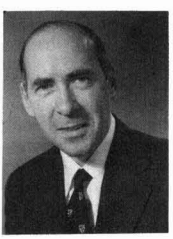


Fig. 1. The process computer. The left-hand cabinet houses standard Hewlett Packard equipment: digital voltmeter, scanner, tape reader and tape punch. The computer occupies the top of the centre cabinet and the right-hand cabinet houses the Tate & Lyle interface

As the computer system was built into an existing process, many of the stand-by controls are the original process ones. However, when a previously uncontrolled process is put onto computer the "stand-by" control is very simple. It consists of one indicator of the process condition and one regulating device which operates the same unit the computer regulates. The object is to copy, as well as possible, what the computer does.



J. A. Fitzpatrick

Four of the controls are described here in some detail to illustrate some of the uses of a computer in the sugar refining process.

Raw magma control

The ratio of weight of raw sugar to weight of mingling syrup in raw magma is referred to as the "magma ratio". Since the weight of sugar in a charged machine depends upon this ratio, it is important to know what it is and to be able to control it at any desired value the plant can accept. If the ratio is maintained constant, the machine charge and the station throughput will be less variable. Also, since affination wash is usually applied for a fixed time interval, the percent wash on crystal will be constant. Our measurements show the machine charge to change from 340 to 400 kg as the magma ratio changes from 1.8 to 2.0. To achieve maximum machine charges and hence maximum throughput, the magma ratio should be controlled at the highest value the plant can accept.

In Thames Refinery there are two completely independent magma mixers. The computer controls both magmas separately or together as required by process conditions. The raw sugar input to the magma mixer is measured by a bandweigher and the flow of mingling syrup is measured by a magnetic flowmeter. The computer reads both flows every 30 seconds and adjusts the mingling syrup control valve to give the required ratio of sugar to syrup requested by the shift manager. This ratio can be changed at anytime it becomes necessary. In practice it is changed only rarely.

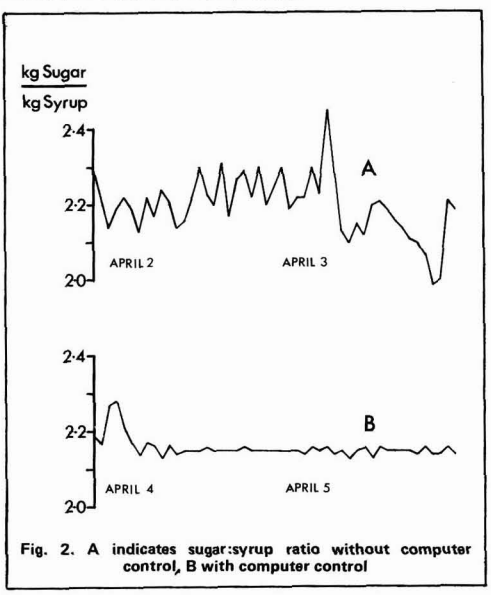


Fig. 2. A indicates sugar:syrup ratio without computer control, B with computer control

The computer reports every five minutes on the state of the control. If for any reason the shift manager is not satisfied that the control system is functioning satisfactorily, he requests the computer to give detailed information. When this request is made the computer prints all the relevant data every 30 seconds. This information is then used to identify the faulty unit in the control system. On two occasions the data indicated the fault was due to a blocked syrup pipe, and on both occasions it was found to be so.

Light liquor flow control

There are several return liquor melters located in the refinery and the liquors from these melters are discharged into the affined sugar melter. The flow and Brix of these liquors vary greatly and, if they are allowed to flow uncontrolled, they cause variations in the Brix of the liquor leaving the affined sugar melter. To prevent this, all return liquors are pumped into a common storage tank, and the computer controls the rate at which they flow into the affined sugar melter.

The control algorithm uses the flow of liquor from the storage tank, measured by a magnetic flowmeter, the level of liquor in the tank, measured by an electronic d.p. cell, and the flow of liquor into the tank which is calculated from the flow and level measurements and the tank dimensions.

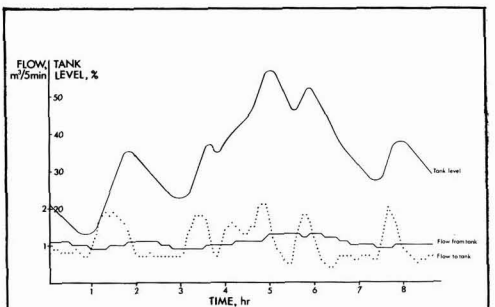


Fig. 3. Light liquid flow control

The object of the control is to minimize the variations in flow of liquor into the melter, by using the storage tank as a buffer. The computer calculates the required flow of liquor and positions the control valve to achieve this flow. The calculation is the summation of the following:-

When the flows in and out are equal, and the level in the storage tank is 50%, the computer makes no change to the flow out. If the level is above 50% the computer increases the flow out. If the level is below 50% the computer reduces the flow out. The purpose of these three actions is to drive the level to 50% so that there is half the tank capacity available to absorb an increase or decrease of flow into the storage tank.

When the flow in is greater than the flow out, the computer increases the flow out. When the flow in is less than the flow out, the computer reduces the flow out. If the flows are equal, no change is made to the flow out. The amount by which the computer changes the flow out depends upon the difference between the two flows and the time it would take to empty (or fill) the available tank capacity.

The calculation coefficients have been arranged so that, when the level reaches 95%, the flow out equals the flow in. Hence, the tank level is allowed to vary between 0 and 95%, acting as a buffer between input and output, but it is not allowed to overflow.

Milk of lime flow control

The flow of milk of lime to carbonatation used to be controlled by a conventional pneumatic three-term controller/valve positioner system. Laboratory analyses were carried out to determine how much lime was needed and the controller set-point was then positioned to give the required flow. The controller performance was unsatisfactory and the process attendant made frequent adjustments to the set-point in an attempt to

maintain the flow about the required value. Even with this attention the variations were too large to tolerate.

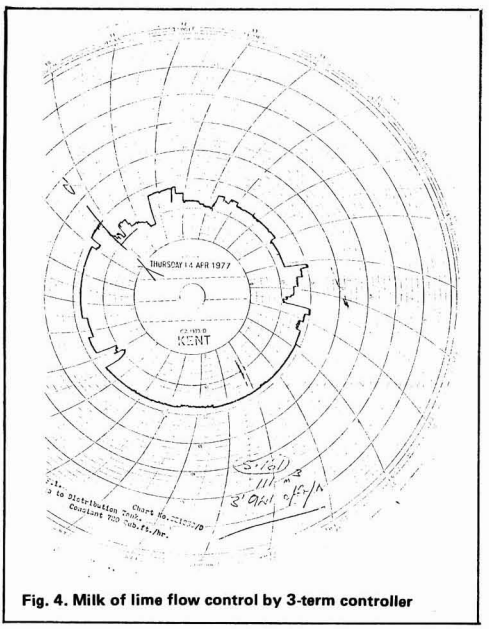


Fig. 4. Milk of lime flow control by 3-term controller

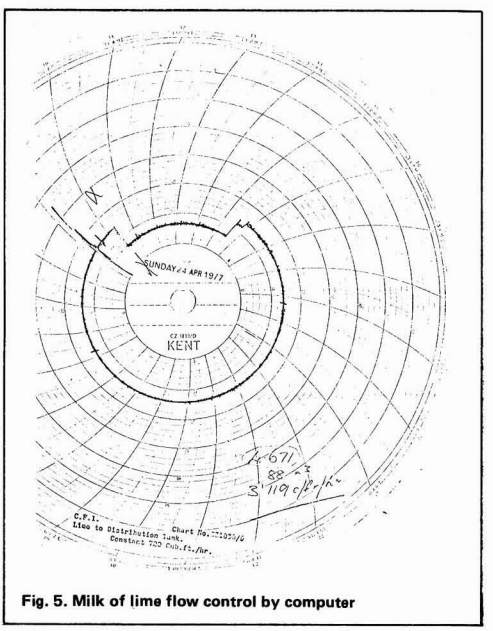


Fig. 5. Milk of lime flow control by computer

When a conventional controller is used to operate a process, the process operation is dictated by what the controller can do. This means that the three controller actions, proportional, integral and derivative, are combined in different amounts until an acceptable performance is achieved. Sometimes the controller actions cannot be combined to produce an acceptable plant response. When a computer is used to operate a process, the process operation dictates the computer actions. This means that the computer can be programmed to provide the actions needed by the process.

The flow of milk of lime is measured by a magnetic flowmeter and transmitted to the computer. The flow rate required is entered into the computer by the chemist using a terminal keyboard. The milk of lime valve is driven by the computer using a Kent electrostep, and the required flow is maintained precisely at all times without attention from the process attendant.

Sweetland presses control

A control system can be considered in two parts: calculating what action to take, and carrying out that action. Applying this to a Sweetland press station, it means calculating when to put a press on and take one off, and doing so. In the most satisfactory control system, the computer has complete control over the action as well as the calculation. This is not so in the control of presses in Thames, as the action is carried out by a plant operator.

There are twenty Sweetland presses in this station, and it would require well over a hundred control valves, with all their associated equipment, to control press actions directly by the computer. Hence, the station is controlled by instructing the plant operator when to put a press on and when to take one off.

Any control system that includes a plant operator, requires additional information and programs. These are needed because an operator cannot respond immediately or precisely to an instruction transmitted by the computer.

This type of control system is the most difficult to commission, but it has been done in Thames and is very successful. Also, it has been achieved with little additional equipment, namely twenty switches, one on each of the clear liquor valves on the presses. The success is partly due to the instructions to plant operators being simple, unambiguous and only four in number. But meetings with all plant operators to discuss the system, prior to commissioning and again after commissioning, are considered to be a significant reason for the success.

The effect of controlling press operations from the computer was to reduce by 30% the number of presses put on. The computer obviously cannot improve filtration but it can make better use of plant and it can show clearly the scope for increasing the throughput if required.

The objects of the control are: to use all presses in a similar way; to take off the press which has been running for the longest time and put on a clean press; to adjust the interval between putting presses on to achieve the required throughput of pressed liquor. When filtration is poor, nineteen presses will be running and one will be off for cleaning. When filtration is good, or the required throughput is low, the number of presses running will be reduced to the appropriate number that gives the required throughput.

The control algorithm computes the time interval between presses going on. The algorithm is based upon the filtration equation

$$\frac{dV}{dt} = \frac{Apg}{m} \Big/ \left[\frac{rCV}{A} + R \right]$$

where V is volume of liquor, t is time, A is area of filter, p is pressure drop, g is acceleration due to gravity, m is viscosity, r is cake specific resistance, C is cake per unit volume and R is cloth resistance.

Simplifying assumptions appropriate to operation in Thames were made, and the interval between presses going on is dependent primarily upon the required liquor flow rate and the number of presses available to filter the liquor.

Instrumentation

All instruments used in the computer system are conventional instruments. Liquid flows are measured by magnetic flowmeters, gas flows by orifices and electronic d.p. cells. Resistance thermometers are used to measure temperature, strain gauges to measure pressure, electronic d.p. cells to measure level and resonance to measure density. Any instrument which does not measure accurately and continuously for at least one year without requiring attention is excluded from the computer systems.

To achieve this condition we install only electronic instruments, and the average time between instrument failures in our process computer system is five years. Over half these instruments have required no attention in the ten years the system has been operating.

Demanding one year of trouble-free operation from all instruments prevented us from measuring density until three years ago, when Solartron and Bell & Howell introduced their meters based upon the tuning fork. Although pH is an important measurement in sugar refining, it is still not included in our computer systems.

No instrument manufacturer produces an instrument which has an output suitable for transmitting the measurement directly to a computer. Both instrument and computer manufacturers make devices that convert all instrument output signals (e.g. 4-20 mA) to the binary signals required by computers. We have used these devices but now we have designed our own converter because it is simpler, more reliable and cheaper than devices on the market.

For system accuracy and reliability we use electronic devices for most requirements, the one exception being the control valve. Pneumatic control valves are the most efficient valves for our applications and all our control valves are pneumatic. The control signal from the computer is converted to pneumatic by Kent electrostep devices located adjacent to the valve and these systems perform very well.

Programming

Some computer manufacturers supply a software system (programs) for process control applications. These systems consist of three parts: programs to operate all the equipment supplied by the computer manufacturer, a framework for the user to add programs to operate the process, and a section to control the priorities and sequences of program operation. The user writes programs (usually in fortran) to operate the process, and fits them into the software system according to the method specified by the manufacturers. These systems require a lot of memory and a disc memory has to be bought with the computer to provide the total memory requirement.

We design our own software system in Tate & Lyle as well as writing all the programs to operate the sugar refining process. By designing our own software we get a more efficient system and buy less computer equipment. The computer manufacturer's software has to satisfy all the different needs of many customers, whereas our software performs only those operations required by our process. All our programs are written in assembler language and the complete system resides in computer main frame memory. Hence, we do not use a disc memory system with our computers.

Our software system does include some programs supplied by Hewlett Packard. These programs are basic library routines and programs to operate the standard computer peripherals including CRT displays, printers, punches and photoreaders. The Hewlett Packard programs occupy less than 4 K of the computer memory.

Fig. 6. Control panel on recovery pan floor. The panel has five sections, one for each pan and a section housing a CRT display. Six push buttons under the display allow the panman to select any one of six detailed reports of process operation

Interface

An electronic system, usually called the interface, is required to connect the process instruments and controls to the computer. The interface provides four basic requirements: analogue signals from process instruments have to be converted to digital form in order to be fed into the computer (A/D converters), digital signals from the computer have to be converted to analogue form in order to operate process plant (D/A converters), contact signals from the process have to be adjusted to the appropriate voltage before being fed into the computer, and contact signals from the computer require power amplification in order to operate process plant. The equipment to perform all these function can be purchased from computer manufacturers with the programs to operate the various units. Alternatively, equipment can be designed and built to satisfy the specific requirements

of the process.

In general, the computer manufacturers' equipment to handle contact information is simple and efficient, but the equipment to handle analogue information contains redundant facilities for most applications and is expensive.

When we installed our process computer system ten years ago, we used the Hewlett Packard equipment to handle digital information, but the equipment to handle analogue information was designed and built by Tate & Lyle engineers. A year ago we installed our recovery process computer system. With the knowledge and experience gained from the process computer system, the entire interface was designed and built by Tate & Lyle engineers in Thames Refinery. The result is a very efficient interface; it has no redundant circuits and can be expanded to perform many more functions when required.

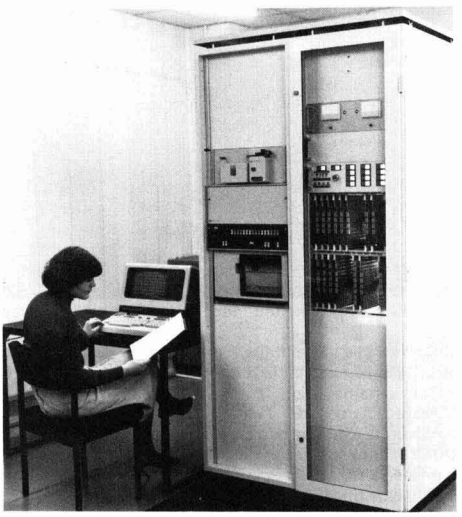


Fig. 7. The Recovery computer. The left hand cabinet houses the tape reader, computer and tape punch. The Tate & Lyle interface is housed in the right hand cabinet. This installation is half the size of the process computer but has twice its power

The interface is made up of four types of cards to perform the four basic requirements listed above. All cards connect sixteen imputs or outputs to the computer. This provides for the most efficient transfer of data since our computers operate on words of sixteen bits.

Current projects

Some of the equipment we require cannot be bought from manufacturers so we design and build these in Thames Refinery. Also we are continuously studying new technologies to see what advantages they hold for the sugar refinery and some of our current projects reflect this.

Flow control of liquors from char cisterns. — The generally accepted way of controlling the flow of liquors from char cisterns is to use "rate boxes". The flow rate through such a device is based upon flow over some kind of weir. To obtain accurate flow measurement by this method requires a number of rules to be obeyed. In sugar refineries we break all these rules. Measurements made by a magnetic flowmeter showed errors of up to 20% in our estimate of flow using rate boxes.

One alternative to a rate box is a magnetic flowmeter but, as there are 32 cisterns in Thames Refinery, we do not wish to solve our measurement problem this way. A system is being introduced to control the flow rates of all cisterns running full weight liquor, sweetening-off and running to sewer using three magnetic flowmeters. The installation of the first stage has been completed and commissioning is about to start.

Computer control of pneumatic valves. — Pneumatically operated valves are the best for control purposes but, when these valves have to be operated by a computer, a number of intermediate instruments are required. A digital-to-analogue converter changes the binary output of the computer to an electrical signal. An electrical-to-pneumatic converter changes the electrical signal to a pneumatic signal. The pneumatic signal is fed to a valve positioner which moves the valve.

A converter is being developed to replace these three units by one unit. The unit, to be connected to the head of the control valve, will receive binary data directly from the computer and position the valve.

Data transmission system. — There are two computer systems in the refinery and each system contains measurements from over one hundred process instruments. More use could be made of these measurements if appropriate ones were transmitted to selected process locations. The conventional method of installing a transmitter at the computer, a receiving terminal in the process and running a connecting cable is the correct way when only one installation is required. We wish to transmit data to and from two computers and three process locations. Further, we may wish to add more receiving terminals. A conventional installation of this size would be costly and inefficient.

A data transmission system of our own design is being installed. The system is a data ring main which provides all the facilities we require with the absolute minimum of equipment and more data terminals can be added very simply if required.

Another project, which comes under the heading of data transmission, is the use of fibre optic cables. A major problem when transmitting measurements from the process to a central station, in our case a computer, is to ensure that the signals arrive in the same condition in which they were sent. In other words, the measurement received is the measurement sent. The conventional method of sending measurements is by copper cables. Unfortunately one has to ensure that the copper cable does not pick up other electrical signals from electrical equipment it passes en route to the computer. Screened cables have to be used and routes selected for the cables that keep them well away from electric plant and other cables.

Signals transmitted along optical fibres are completely unaffected by electrical equipment. This means that the optical fibre transmission lines can be run from measuring instrument to computer by the shortest route. A cathode ray tube type display terminal at the recovery pan floor receives its messages via a 66-metre length of fibre optic cable from the computer. This cable was deliberately run close to both continuous and batch machines to show that it would not pick up signals from electrical plant and power cables.

Microprocessors. — We have been studying the electronics and programming of microprocessors for two years but, so far, we have not used one in any of our systems. The reason we have not done so is that we have not found one which we consider suitable for our types of application.

The application of computers and electronics

Manufacturers make microprocessors for use, mainly, by the computer industry. They develop a microprocessor system, install it in, say, a display terminal and then sell thousands of identical units. We wish to develop a microprocessor system for a one-off job. As a microprocessor costs about £20 and the equipment to program, test and monitor the operation costs up to £1000, it is unlikely to be economical.

Most microprocessors are TTL logic which means that, although they might perform perfectly in an office environment, they are not suitable for installing in a sugar refinery adjacent to some electrical equipment.

The program instructions are designed for data manipulation and to operate with large memory systems. This results in many instructions performing almost identical operations. We require relatively few simple instructions that operate efficiently with a small memory, and that perform basic mathematical operations.

The means provided to get data into and out of the microprocessor is inadequate and unnecessarily complicated. Since we are concerned with operating plant and not data manipulation, the input-output facilities are, perhaps, the most important part of the system.

The microprocessor to satisfy our requirements would be part of a "chip" which contained the entire hardware system. It would be CMOS logic so that we could install it in process areas. The chip would contain the microprocessor, 500 words of 16 bits to hold the user program, read-only memory to provide basic floating point arithmetic ($+, -, \times, \div, \sqrt{}$), a hardware clock for timing purposes, one input-output channel for connecting a conventional keyboard terminal, four analogue and four digital inputs, two analogue and two digital output channels. If more inputs or outputs were required, they could be obtained by using extra chips in series or parallel. The processor should have about 30 instructions and the execution time could be as slow as 50 microseconds.

In conclusion

Electronics, in the form of instruments and computers have allowed us to achieve many things that could not be achieved in any other way. More recently optics have been included in our systems, and their use is expected to increase rapidly. What technology will be the next to be included in our systems is not known. It could be the use of infrared devices.

Summary

Two computer systems installed at Tate & Lyle's Thames Refinery are described and an account given of their operation, with specific examples. Current projects on application of the computer in sugar refinery technology are discussed as is the potential for new types of equipment.

L'application d'ordinateurs et de l'électronique pour réglage de procédés dans la raffinerie Thames

On décrit deux systèmes à ordinateur installés dans la raffinerie Thames de Tate & Lyle, et donne compte de leur opération, avec des exemples spécifiques. On discute des projets actuels sur l'application de l'ordinateur dans la technologie de la raffinerie de sucre, comme aussi le potentiel de nouveaux types d'équipement.

Die Anwendung von Computern und der Elektronik zur Verfahrensregelung in der Zuckerraffinerie Thames

Beschrieben werden zwei in der Raffinerie Thames von Tate & Lyle installierte Computersysteme; ihr Einsatz wird mittels spezifischer Beispiele erläutert. Gegenwartsprojekte für Anwendung des Computers in der Zuckerraffinationstechnologie werden erötert, wie auch die Möglichkeiten für neue Einrichtungsarten.

Aplicación de computadores y sistemas electrónicas al control del proceso en la refinería Thames

Dos sistemas con computadores instalado en la refinería Thames de Tate & Lyle se describen y su operación se examina con ejemplos específicos. Proyectos actuales sobre aplicación del computador en la tecnología de refinería de azúcar se discute tanto como el potencial para nuevos tipos de equipo.

New equipment for the automation of cane sugar factories*

By P. N. PAUL OLSEN
(Automation Division, Dynamotors Ltd., Mauritius)

Introduction

Since we are to be concerned with automation, I think it would be useful to summarize the basic principles and the usual equipment for control techniques. The simplest apparatus consists of a single closed loop. Let us take the example of temperature control; here the required temperature is set and a continuous comparison made between this and the temperature measured by the transducer. The heating effect will be proportional to the difference between the temperature required and that measured.

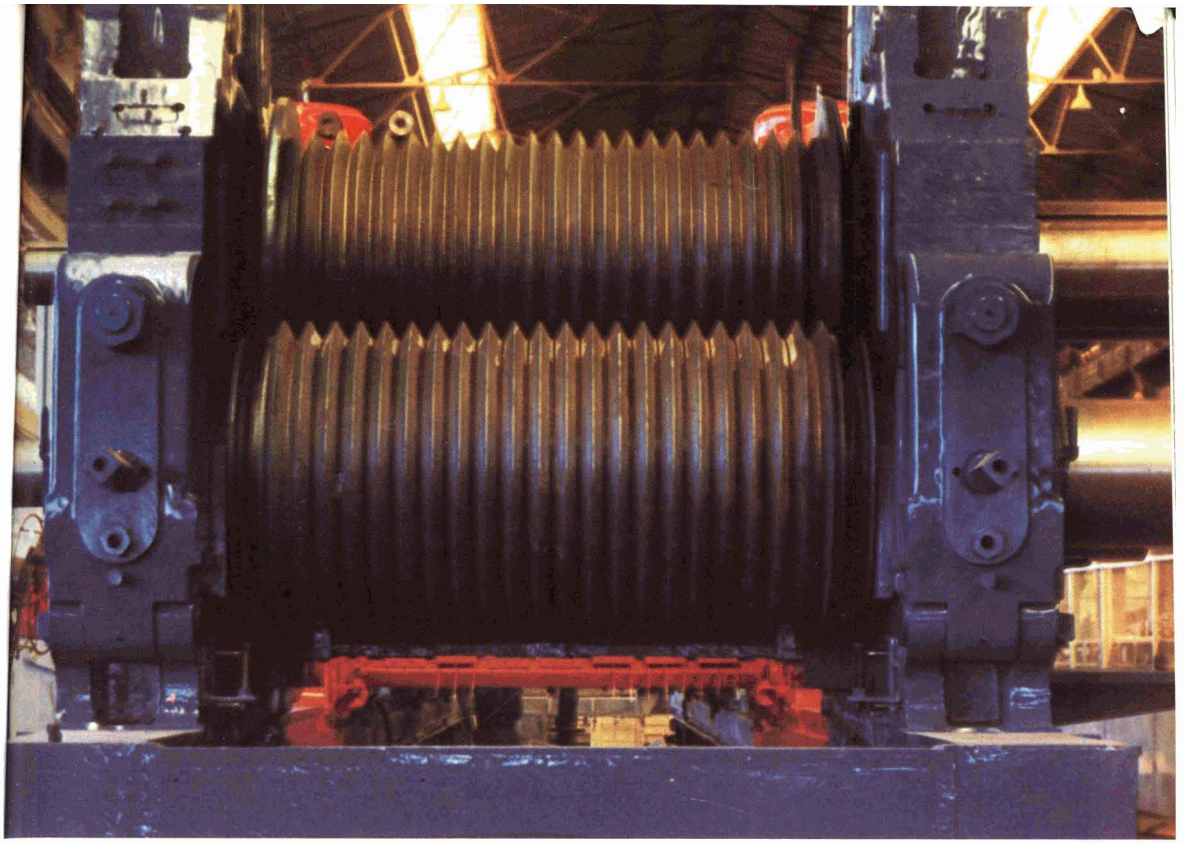
So as to stabilize the controller and to compensate for the effects of external disturbances, we add to this kind of control an integrator and a differentiator. We then obtain a PID control element of the sort which has been in existence a long time in the form of pneumatic or electronic equipment and which is the type currently in use in our sugar factories.

In certain cases the external disturbances are such that the PID control element which I have just described is inadequate to maintain the regulated parameter within acceptable limits.

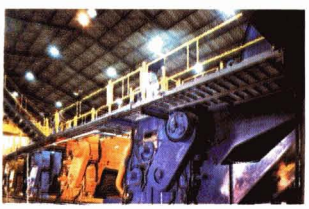
Multiple entry analogue controller

Let us take the case of pH control in the liming station; we add to juice continuously milk of lime in a proportion which depends on the difference between the pH required and that of the incoming juice. The system tends to stabilize itself if the juice comes to us in a regular fashion at a constant pH. In practice, juice flow can change in a sudden manner which requires an immediate correction to the flow of milk of lime. This

* *Paper presented to the 2nd Congress ARTAS*



Trapiches Zanini, el dulce sabor del suceso.



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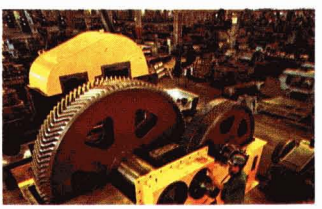

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correction will not take place, however, until the moment when the limed juice pH has changed. This is precisely what we do *not* want, our objective being a constant pH.

This type of problem has given rise to a range of control instruments providing an immediate compensation with the aid of signals which permit anticipation of the path to be followed, always maintaining the closed loop of measurement of the regulated parameter. In the case of pH control, the instrument would be provided with a flowmeter at the juice entry and would maintain the proportion of the mixture in the case of a variation in juice flow without the final pH being affected.

This type of equipment marks a decisive stage in development of the controller: a system able to accept multiple entries and becoming capable of anticipation. Unfortunately, these advantages carry with them complexity and specialization of the control elements.

To design this type of equipment it is necessary to know the mathematical relationships between the output and the different inputs, and then to interconnect mathematical function modules according to the process diagram established. It is evident that the more precise the process control that we want, the more complicated and expensive will be the controller. Furthermore, such instruments are very specialized and will serve for only one application.

Process control by computer

It is at this stage that we come across the use of computers for the control of complex processes. Here, the approach is different. Instead of perfecting the instrument by adding, each time, modules for additional functions, we only utilize a single module for handling information – this is the central processor of the computer. We ask it to carry out sequentially, according to a pre-established program, all the arithmetic operations which were formerly carried out by the individual function modules. This is possible because the time for execution of a stage of the program by the central processor is extremely short compared with the evolution of signals coming from the installation being controlled.

Operation of a computer

Every computer comprises three main blocks each having a defined function (See Fig. 1):

(1) the central processor which has as its function the handling of information;
(2) the memory, which as its name indicates, serves to memorize the sequences of the program and the data to be manipulated; and
(3) the lines of communication with the outside (the peripherals).

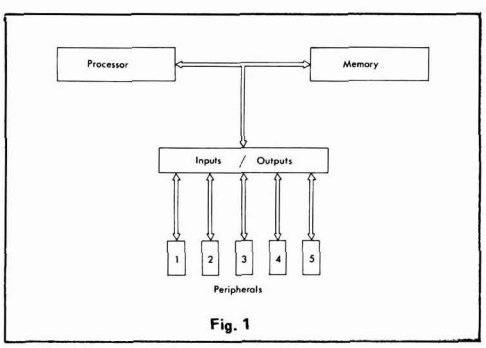

Fig. 1

A computer is an instrument of universal application. It will be the programs we feed into it and above all the peripherals connected to it which will determine its operation. With a keyboard, a visual display unit, a printer and the related programs, we have a management tool. With pressure, temperature and flow transducers and control elements such as pneumatic valves, and the appropriate programs, we have a computer system for process control.

Let us now look at how a memory is arranged (Figs. 2 and 3). Memories may be classified according to the method of access to the information[1]. They may be of random, sequential or associative access. We will only describe the first which are the only ones of interest to us.

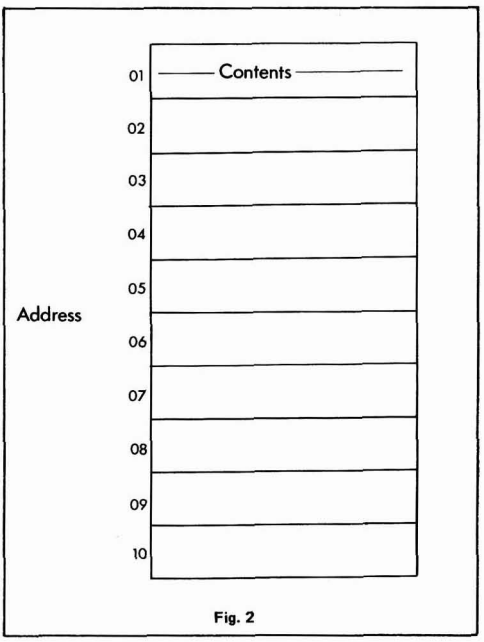

Fig. 2

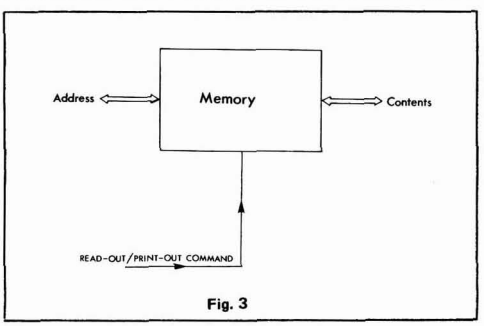

Fig. 3

The random access memory resembles a card index file where each word of information is placed at a precise address. Each address is numbered and it is sufficient to indicate to the memory the number of the

[1] Lilen: "Du micro-processeur au micro-ordinateur" (Edition Radio, Paris) 1977.

address to be able to read or write the information.

For the processor to function, we must write in advance in a part of the memory all the instructions of the program. Another part of the memory will contain the data. Other data come into or leave the processor by the input/output ports during the carrying out of the program. The sequence of operations is as follows (see Fig. 4):

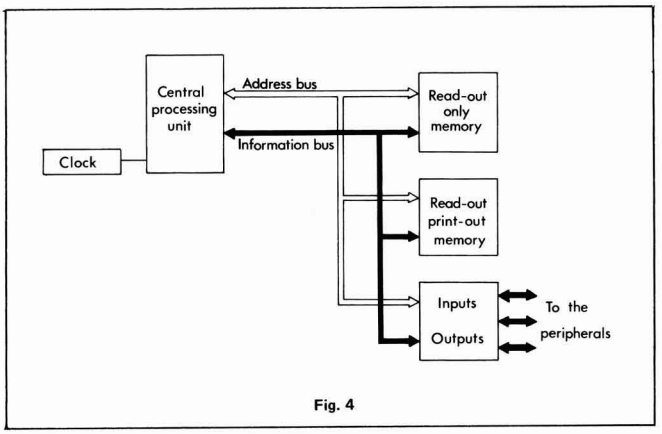

Fig. 4

The program counter of the processor is first of all initialled at the first address of the program. The processor puts the value of this address on the address bus. The memory then returns to the processor an instruction which is brought to it on the information bus. The processor decodes and executes this instruction and the program counter addresses automatically the next segment of the memory where the processor will find either the address of a piece of information which must be handled or the next instructions, and so on until the end of the program. It is the clock (a fixed frequency impulse generator) which determines the rhythm of the operations.

The instructions which can be performed by the central processor are:

(1) arithmetical operations;
(2) logical operations;
(3) conditional or unconditional jumps.

Summary of the advantages and disadvantages of computer control

Process control by computer has the following advantages by comparison with traditional techniques:

(1) It permits the standardization of equipment, the same processor being able to perform different tasks according to the program given to it;

(2) It permits a greater flexibility of use than set function control, the program being able to be modified at any time;

(3) It permits a greater reliability, the software (the set of programs) being of a more reliable nature than the equipment it replaces.

The utilization of a classical computer has serious limitations, however, for the control of simple processes because of the following disadvantages:

(1) The need to carry out sequentially numerous control loops with the same processor in order to justify its high price;

(2) The consequential demand for miles of cable in view of the position of the central computer linked to numerous, often far-removed peripheral units.

(3) A breakdown of the central computer paralyses all the installation.

The advent of micro-processors

The technologies of manufacture of integrated circuits being well-known, spectacular developments in recent years permitted in 1975 the integration on a single silicon chip of a few square millimetres surface of all the essential elements of a computer's central processor, that is, about 60,000 transistors.

The micro-processor associated with integrated memory circuits, peripheral interface circuits and some auxiliaries, allows the building of a micro-computer of small dimensions and at low cost.

The advent of the micro-processor will have an impact on all industrial society and, of course, in the field of automation. Instead of using a classical computer which must be optimized by connecting with a maximum number of independent control loops, it becomes possible to build small individual processors, all physically identical but each with a specific program giving it a precise function. The greatest economy will come from the fact that it is not necessary to have facilities to edit, assemble or compile programs in each individual micro-computer.

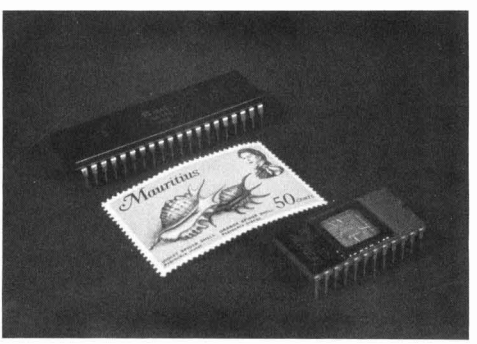

Fig. 5

All these operations can be done by a much more expensive single system comprising alpha-numerical key, display console, disc memory and printer. Such a system, known as the software development system, permits the writing and verification of the functioning of a program and then the transfer of this program to an integrated-circuit semi-permanent memory of low cost implanted in the control module of the final system. Since the program contained in this memory can only be erased with the aid of an ultra-violet source, the machine maintains its program indefinitely unless voluntary action is taken to modify it.

Programming languages

A computer may be programmed in different ways, the most direct consisting of listing the instructions and

corresponding memory addresses according to a code directly exploitable by the micro-processor, that is to say in binary or hexadecimal. This is what we call programming in machine language. This method of programming is very slow and consequently very little used for the writing of long programs.

Another process is used to program in symbolic language, that is, each machine instruction is coded according to a specific alphabetical abbreviation. The abbreviations are easier to memorize than the hexadecimal, and the programmers make fewer errors. In this case, the development system possesses an assembler that will make the translation from symbolic language to machine code directly usable by the processor. The assembler also possesses other facilities which make it more efficient in programming in machine language.

However, the most widespread method of programming is the use of high level language, orientated to specific applications, for example Cobol for business systems, Fortran and Algol for scientific work, etc. The programmer writes in English short coded phrases each of which gives rise to a number of machine instructions with which the programmer will not need to concern himself.

The translation of the source program edited in high level language into an object program (machine language) is called compilation. The compiler converts a source instruction into several machine instructions, is concerned with defining and absolute memory addresses and indicates to the programmer syntax errors in his programs. The high level language has also the advantage that a program can easily be transferred from one machine to another.

The choice of the type of language to be used will depend on the facilities available and the complexity of the program one wishes to write. The time necessary to write and to verify a program will be, in relative value, about 1 with high level language, 5 with an assembler (symbolic language) and 25 with the hexadecimal (machine language).

The multi-processor system

We have seen above the disadvantages of a central computer controlling an entire factory. This was, however, the only economical solution a few years ago. The appearance of micro-processors has upset all the facts of the problem in view of their extremely low price (Fr. 50 – 500). Each part of the factory, for example, the feeding, milling, liming, evaporation, etc., may be controlled by an individual micro-computer with a second as standby, price permitting. Each of these control stations may be interconnected with the others by means of an information bus. A control station connected to this bus permits an operator to interrogate successively the individual processors and to display all the process states.

The information bus interconnecting the individual processors is not indispensable to the operation of the factory but prevents accumulation of raw material at any point in the factory and optimizes the complete installation. For example, a stoppage of the mills will immediately reduce the feed to the boilers.

Conclusion

The first tests on use of micro-processors in the sugar industry were carried out in Europe for automatic boiling control. They took place at Toury and Guignicourt beet sugar factories in France and at Bury St. Edmunds in England[2].

The Australians, who have considerable experience in control by the conventional computer, will undoubtedly already have carried out tests with micro-computers.

As regards Réunion and Mauritius, I think that the fact that these new techniques involve lower investment than classical computers will make them very suitable for our sugar factories and allow us to reduce operating costs.

Acknowledgment

I wish to express my gratitude to M. Sylvio Marie-Jeanne of the Mauritius Sugar Industry Research Institute, for his valuable help in preparing this paper. My thanks go equally to the following organizations for permission to use photographic documents: Scientific American, Intel Corporation and Fairchild Camera & Instrument Corporation.

Summary

This communication makes mention of recent progress in the field of information, notably the appearance of micro-processors, and the useful employment of these techniques for the automation of cane sugar factories.

Nouveaux matériels d'automation pour sucreries de cannes

Cette communication fait mention des derniers progrès dans le domaine de l'information, notamment l'apparition des microprocesseurs, et de l'usage utile de ces techniques pour l'automation des sucreries de cannes.

Neue Ausrüstungen für die Automation von Rohrzuckerfabriken

Dieser Bericht erwähnt neuere Fortschritte im Bereich der Information, insbesondere über das Erscheinen von Microprozessoren und die nutzvolle Anwendung dieser Techniken für die Automation von Rohrzuckerfabriken.

Nuevos equipos para automación de ingenios azucareros

Esta comunicación hace mención de progresos recientes en el campo de información, especialmente la introduccion de microprocesores, y el empleo útil de estas técnicas para la automación de ingenios azucareros.

New Kenya sugar factory[3]. – The South Nyanza Sugar Co. plant at Awendo has been completed, at a cost of 800 million shillings. It has a production capacity of 60,000 tonnes per year but the initial target is 24,000 tonnes. Cane yield, at 150 tonnes.ha^{-1}, is much higher than the original projections of 120 tonnes.ha^{-1}. The project, which has been funded by the Kenya Government and a number of development agencies, is managed by the Mehta Group and has 1500 full-time employees, a similar number of casual workers, and receives cane from 1500 outgrowers.

New Mexican sugar factories[4]. – The Comisión Nacional de la Industria Azucarera has announced the erection of seven new sugar factories, involving a total investment of $440,000,000. Two new mills, in Juchitán (Oaxaca) and Huixtla (Chiapas) are already under construction and may begin operation in the latter half of the 1979/80 season. The Commission considers that erection of the seven factories will permit self-sufficiency and the possibility of renewed sugar exports. Mexico's national plan provides for an increase of 700,000 tonnes in production capacity. Production had reached 2.8 million tonnes, tel quel, in 1979 and should reach 3-3.3 million tonnes in the next few years.

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[2] Windal: *Sucr. Franç.*, 1977, **118**, 129-135.
[3] *Standard Chartered Rev.*, April 1980, 14.
[4] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 226.

The use of small computers in British beet sugar factories

By J. S. HOGG and D. F. A. HORSLEY
(British Sugar Corporation Ltd., Peterborough, England)

Introduction

In the past two decades there has been a rapid development in computer techniques, both hard and software. Although the software advances have been significant, it is in the hardware area that the most spectacular and widely reported advances have been made.

"The Computer" is no longer a large data processing machine suitable for centralized number crunching. Now the hardware has become so small and inexpensive that it can be used anywhere in the sugar factory. Along with this hardware development, there has been a corresponding improvement in software, particularly in tailoring the operating systems to be usable by persons with application knowledge rather than programming expertise. Thus, the computer is no longer solely a data processing machine but is also a general purpose engineering tool capable of controlling process plant and machines, collecting data from plant for direct management of the process or for onward transmission to some centralized data processing area. This paper describes where small computer- or digitally-based equipment has been used in the technical areas of the British Sugar Corporation and ends with a short description of possible future applications.

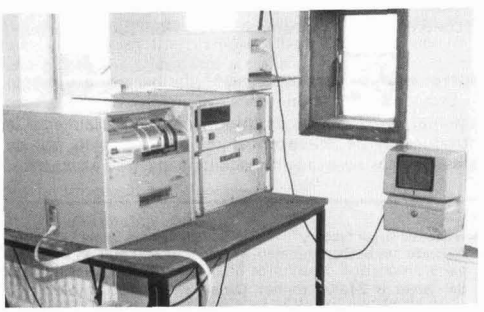
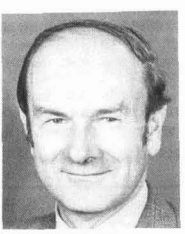


Fig. 1. Sorensen equipped weighbridge at Newark showing left to right: (a) Sorensen recorder/printer producing paper tape record of weighbridge transactions, (b) Avery load cell weighbridge electronics and digital display, and (c) the delivery end of the Sorensen document conveyor

J. S. Hogg



D. F. A. Horsley

Tarehouse data collection

Beet costing data collection has been in use in British sugar factories for many years and has taken a number of forms. Early systems were direct mechanical Sorensen types and later ones were electro-mechanical Sorensen and Stone-Platt systems. These are rigid in their operation and also tend to be available from small suppliers who make equipment to specialized single-use designs. Maintenance is also a problem with such one-off units.

In 1973, the British Sugar Corporation ordered a modern data collection system based on a P.D.P.11 minicomputer but still utilizing specially-designed hardware interfaces to control and collect data from the tarehouse equipment[1]. It is significant that the first 4-bit microprocessor was introduced in 1971 and the very successful Intel 8080 8-bit unit not until 1973. The system ordered was therefore based on technology some years old. However, it was a successful installation and has been working at our Ipswich factory virtually unmodified.

Fig. 2. Ipswich weighbridge installation showing Avery weighbridge electronics in the background, operator's data entry panel and weigh ticket printer in the foreground, and Sorensen document conveyor on the right

The next step was in 1975 when a similar but updated system was ordered for our Bury St. Edmunds factory. This system, as well as dealing with data collection, was also arranged to give certain management information via a V.D.U. (visual display unit) terminal. Again, the P.D.P. 11 was used with a specialist hardware interface. The system is successful but access to the management information is rather slower than would be preferred because of the size of machine and the configuration of the disc equipment.

The lessons learnt from these two installations will be incorporated into our next range of equipment which will be based on standardized input-output interfaces for data acquisition and will probably be able to transmit information direct to data processing computers.

[1] Horsley & Williams: *Paper presented to the 24th Tech. Conf., British Sugar Corp. Ltd.*, 1978.

Laboratory

The use of small computers to assist with laboratory work is well established. The Dutch company C.S.M. has used computers extensively for the control and acquisition of data from standard and specially developed analysis equipment[2]. BC Sugars has reported on the use of computers for calculation of chemical control data[3]. In British Sugar we have not yet seen the need or benefit of having fully automated laboratories or large scale data processing of chemical control results. We have, however, carried out work at two centres with the use of small "desk top" machines.

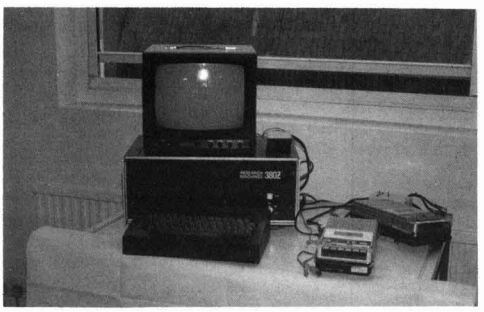


Fig. 3. Microprocessor-based computer and V.D.U. used in the Newark laboratory data recording and calculation system

At Newark, the work has been concentrated on the processing of manually entered data to provide the necessary daily, weekly and campaign-to-date information for process management[4]. The work has also included successful trials of an information system Labfax" where the data stored in the laboratory machine are made available on a V.D.U. system at key points in the factory. It is expected that such a system will be integrated with the extensive closed-circuit T.V. system used for plant observation and control, thus making information available immediately where it is most needed on equipment already available on the plant.

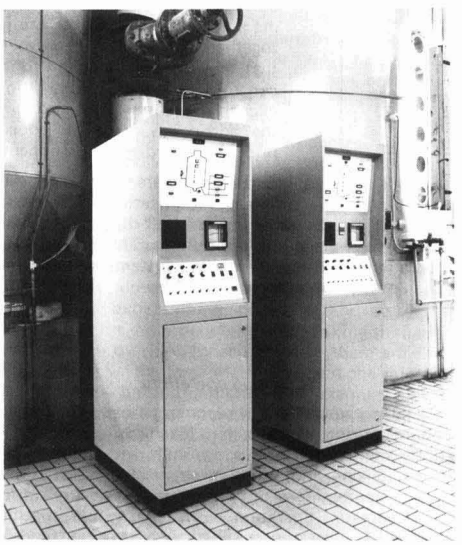


Fig. 4. Bury St. Edmunds first two production pan control cubicles installed 1977

At our Selby factory the work has concentrated on the control of two important items of laboratory equipment and the processing of the data obtained. The refractometer and density meter are linked directly into the computer and the bench hand communicating through a V.D.U. has control over the analysis and calculation of data from samples. This system has also used a V.D.U. for displaying purity and pan charge volumes to the pan floor operators. The machine at Selby was available to all laboratory personnel and it is interesting to note that, without formal instruction, many useful programs were developed so that, by the end of the campaign, a "menu" of laboratory programs was available to all in the laboratory.

Pan boiling

It is in the area of automatic control of vacuum pans that the greatest amount of development effort has been expended, although it must be remarked that the greatest part of the effort has not been directed towards the digital equipment but towards identifying the process to be controlled. The early work on the development of an automatic control system has been well reported by British Sugar Corporation staff[5-7].

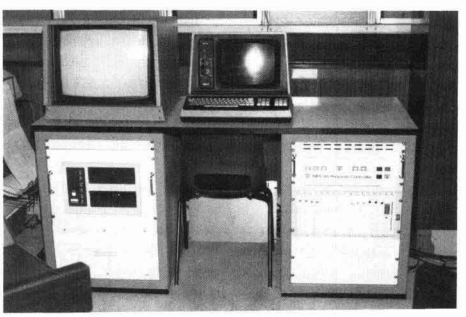


Fig. 5. The Newark prototype distributed system

Present work is directed firstly towards understanding the process more fully so that better measurements and more sophisticated controls can be used, and, secondly, towards a form of distributed control that will eventually give two main benefits. One will be the provision of management information; the present hand-written "Strike Log" will be produced automatically and shift/to-date logs of pan floor performance will be available. The second benefit will be the co-ordination of pan floor operations that will result in reduced fuel consumption from the scheduling of pans and the prevention of delays by looking at storage capacity of liquors and storage and spinning capacity for masse-cuites[8,9].

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[2] van der Poel *et al.: Paper presented to the 24th Tech. Conf., British Sugar Corp. Ltd.*, 1978.
[3] Karren & Faviell: *ibid.*
[4] Vyse & Marten: *ibid.*
[5] Withers & Bass: *Paper presented to the 18th Tech. Conf., British Sugar Corp. Ltd.*, 1966.
[6] Bass *et al.: Paper presented to the 23rd Tech. Conf., British Sugar Corp. Ltd.*, 1976.
[7] Hogg: "The Application of Microprocessing to Control of a Batch Process", *Paper presented to Food Industries Conf.*, 1979.
[8] Hammond: *Chairman's Address to I.E.E. Computing & Control Division*, 1979.
[9] Hammond & King: *I.E.E. Electronics and Power*, January 1980, 38-45.

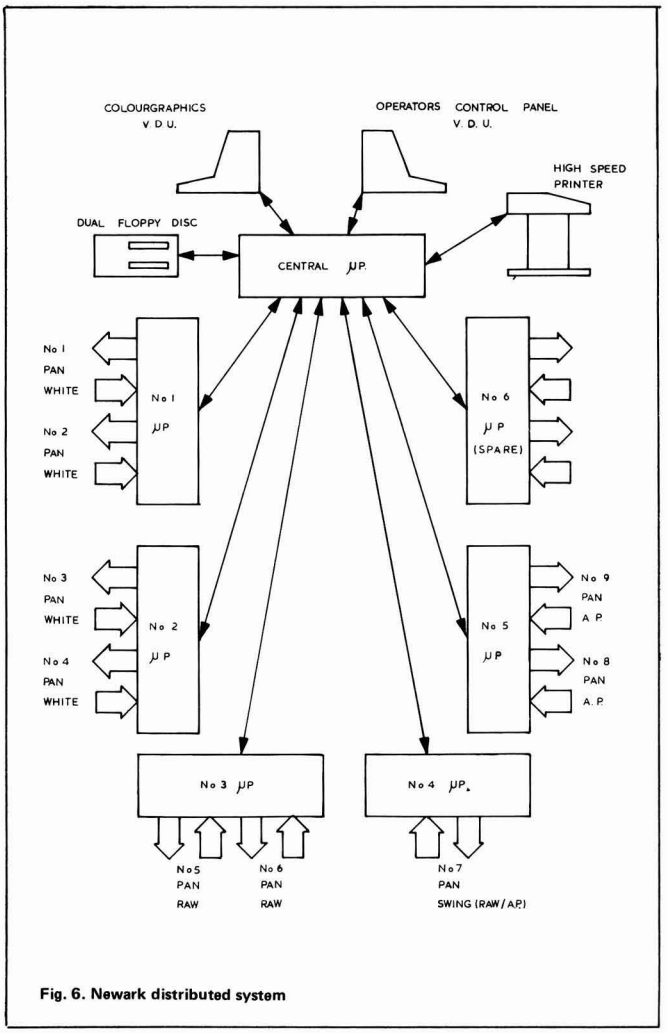


Fig. 6. Newark distributed system

Lime kiln control

The automatic control of lime kilns has been common for many years. However, until recently, all such systems have relied on a combination of analogue weight calculation and batching control with relay sequence. Microprocessor techniques now available allow sophisticated batch and sequence control equipment to be manufactured for about the same price as a simple analogue batch weigher. At our Ely factory, we have replaced the analogue weigher with digital equipment allowing easy adjustment of batch weights, compensation for materials "in flight" and control of the feeder sequence. The first campaign of operation has been very satisfactory.

Juice decalcification and boiler water treatment

These two processes are similar in principle, both relying on ion exchange resins, although the boiler system employs several resins to give complete demineralization. From a process control point of view, the problems are similar and up to now have been solved using conventional instruments with a sequence control based on relay and uniselector logic with selection of the valve to operate being programmed on a diode-pin matrix board. The latest microprocessor-based programmable logic controllers are now offering some process control features together with sequence control so that they are ideally suited to the control of multi-column ion-exchange plants. They also have the added advantage of reduced price, standardized components, high level albeit specialized software permitting easy programming and program modification. The better units also incude a degree of self-diagnosis against hardware/software and plant failures. The British Sugar Corporation will be installing two systems in 1980, one on each of the two processes.

Fig. 7. General view of the Newark sugar end control room

Packeting operations

Packeting machinery is becoming more complex and is also changing in character. Machines are no longer entirely controlled from a camshaft with levers, links, rockers, chains and other mechanical devices. Rather they are combining a mixture of mechanical, electrical and pneumatic operation with the whole machine controlled by electronics. There is a growing trend for the electronics to be microprocessor-based and hence programmable. Such machines are already in use in the

Corporation, notably in the direct palletization of 1-kilo packs of sugar into 1-tonne lots. This process is carried out automatically using a palletizer and stretch wrapper.

Engineering calculations

Lower cost computing now means that technical departments are able to have their own computing facilities. These may either be (a) terminals to a main frame computer, (b) a mini-computer linked to a main frame computer or (c) an independent mini-computer. In British Sugar Corporation's Central Design Office, where much of the process parameter calculation for new plant and modification to existing plant is carried out, complex calculations have been carried out on a batch basis using the main frame computer. It is now proposed to implement system (c) above in such a way that it can be converted to (b) in the near future. This will make the use of computational techniques much more widely available to process designers, improving the speed with which design change effects can be assessed.

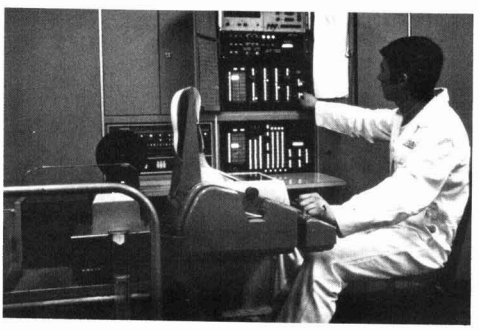


Fig. 8. Operator using the Wissington computer

Conclusions

The use of small equipment fitted directly on plant is now well established and is an area that will grow in the British Sugar Corporation just as it will grow throughout the rest of industry. As equipment is developed, engineers and process managers will want to link together the smaller machines for the same reason as we have linked our pan boiling machines at Newark. They will wish to have data at some central point in order to log operating conditions and also to control all parts of a process to respond to changing operational conditions. This will result in a distributed control equipment structure.

This structure will be similar to the primarily data processing structure, except that, whereas the plant items are linking upwards to a larger machine, the D.P. system links downwards to smaller machines. The direction of expansion is different, and so are the reasons, but the final networks have striking similarities.

Is there an overlap? Indeed there is; there are clearly the extremes — the large mainframe and the micro out on the plant — but in the middle there are machines that appear to have similar technical specifications in terms of speed, memory, etc., but they are quite different in software and operating requirements. At the user level they also need different staff to operate them. The traditional Data Processing system requires a disciplined, almost routine, approach because of the nature of the information dealt with. The engineering process control systems need a different approach where the main requirement is a deep insight into the problem and the computer system is the tool used to solve the problem. Therefore there will continue to be D.P. departments and engineering departments which will work together and cooperate in areas of mutual interest as they have done in the past, but they will each have their computers (macro or micro depending on the task in hand) and they will each be responsible for their own hardware and software. They will occasionally come together in the middle area, perhaps only infrequently in the near future but maybe increasingly more often in the middle future as distributed data processing and distributed process control become more widespread. It will therefore be necessary for large process control and small data processing machines to communicate with each other.

Summary

An account is given of the history of computer application in the British Sugar Corporation with examples of specific areas of factory operation where this equipment is employed. Future developments likely as a consequence of the availability of new equipment are discussed.

L'emploi de petits ordinateurs dans les sucreries de betteraves en Angleterre

On donne aperçu de l'histoire de l'emploi d'ordinateurs dans la British Sugar Corporation avec des exemples de domaines spécifiques de l'opération d'une usine où cet équipement est employé. Des développements à l'avenir, qui sont probables par suite de la disponibilité de nouveau équipement, sont discutés.

Der Einsatz kleiner Rechner in britischen Rübenzuckerfabriken

Die Geschichte von Rechnereinsatz in der British Sugar Corporation wird an Hand Beispielen von spezifischen Bereichen des Fabrikbetriebs, worin diese Ausrüstung angewendet wird, betrachtet. Wahrscheinliche Zukunftsentwicklungen, infolge der Verfügbarkeit neuer Einrichtungen, werden diskutiert.

Aplicación de computadores pequeños en las fábricas inglesas de azúcar de remolacha

Los autores dan cuenta de la historia del aplicación de computadores en la British Sugar Corporation con ejemplos de áreas específicas de operación de la fábrica donde se ha empleado este equipo. Desarrollo probable en el futuro como consecuencia de la disponibilidad de nuevos equipos se discute.

US sugar refinery sale[1]. — The Georgia sugar refinery, up to May 1980 owned and operated by South Coast Sugars Inc., has been purchased by Louisiana Sugar Cane Products Inc., a group formed in 1975 by nine cooperative sugar factories in Louisiana.

Colombia alcohol production plans[2]. — A plan for production of fuel alcohol from sugar cane and cassava has been completed. Production of alcohol to replace 30% of the gasoline used by cars will be made possible by expansion of the sugar cane area from 300,000 to 400,000 ha.

Argentina sugar production increase[3]. — Argentina is expected to authorize an increase in production quotas for sugar factories because of strong world prices, according to the US Department of Agriculture. Sugar output is forecast at 1,600,000 tonnes, 15% above the 1979/80 production of 1,410,849 tonnes[4]. The Department predicts that sugar exports will increase by 63% to 570,000 tonnes in 1980/81.

[1] *Sugar Bull.*, 1980, **58**, (13), 3, 19.
[2] *Westway Newsletter*, 1980, (78), 11.
[3] *Reuter's Sugar Rpt.*, April 29, 1980.
[4] *I.S.J.*, 1980, **82**, 166.

Sugar beet variety testing in England

By D.S. KIMBER, National Institute of Agricultural Botany, Cambridge

The grower's need for independent information about crop varieties was recognised when the National Institute of Agricultural Botany was founded at Cambridge in 1919. Provision of this information was given priority among the Institute's early activities and sugar beet variety testing started in 1925: trials have continued annually since. Trial procedures improved and allowed the introduction of a Recommended List of sugar beet varieties in 1937 which, revised each year, still provides the essential information on which growers choose their varieties.

New varieties, which are tested for a minimum of three years, and all Recommended varieties are included in the trials. Although varieties in the early stages of trial are not subjected to the full range of additional tests, the general procedures are similar for all varieties (Table I). However, work on the commercial varieties is extended to include checks on all seed lots distributed to growers. This paper outlines these various functions, which, although basically similar to those described by Willey[1,2], have been modified in various ways to meet changes in commercial practice and to take advantage of technical developments.

Table I. Number of centres in the NIAB testing program for sugar beet

	Variety testing							Seed stock testing	
	Field trials	Emergence studies	Early-sown bolting plots	Virus yellows tolerance trials	Downy mildew trials	Susceptibility to minor diseases – observation plots	Herbicide susceptibility trials	Emergence studies	Late-sown bolter plots
New varieties									
– Year 1	7	-	-	-	-	-	-	-	-
– Year 2	17	6	17	2*	1	2	-	-	-
– Year 3	17	6	17	2*	1	2	1*	-	-
Commercial varieties	17	6	17	2*	1	2	1*	4	6

* selected varieties only

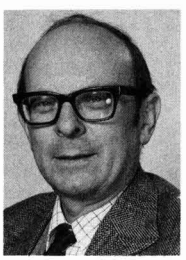
TRIAL PROCEDURES

Field trials

Seed submitted for trial is required to meet statutory germination standards and will have received a fungicidal ethyl mercurial phosphate or thiram soak treatment before pelleting by the Filcoat process, which includes a methiocarb insecticidal treatment. All variety trials are planted "to a stand", i.e. precision drilled, with seed spaced not less than 15 cm apart in the row. The object is to follow farm practice; fertilizer, herbicide or insecticide treatments are decided by the trials officer supervising the trial, who is instructed to follow the "best local husbandry practice", but avoiding those known to have a differential varietal effect. Consequently, treatments will vary from trial to trial.

Trials are laid out using an incomplete block design with four replicates and each plot consists of five or six rows to match the drilling, hoeing and harvesting equipment. The outer rows, being border rows, are not harvested for yield and the total area used for yield determination is 20 - 25 m^2.

The trails are harvested using commercial beet harvesters modified for trial work to permit bagging of the produce. Thus roots are topped, lifted and the produce from each plot bagged and labelled, before transporting to the British Sugar Corporation's Central Laboratory, where the produce from all trials is washed and weighed prior to analysis. This procedure, whereby one central laboratory deals with produce from all trials, has proved more efficient and cheaper than attempting to wash and weigh locally.



D. S. Kimber

It is recognised that, as the harvester is set for a trial rather than for individual varieties, there is a risk of discriminatory topping; accordingly, samples of each variety in each trial are assessed for top tare.

Root analysis

Brei samples are obtained from the washed roots using a multiple saw[3] and analysed for sugar content and also for sodium, potassium and alpha-amino nitrogen from which an impurity figure is calculated using the

[1] *J. Nat. Inst. Agric. Bot.*, 1956, **7**, 592-596.
[2] *ibid.*, 1964, **10**, 98-103.
[3] Parker: *I.S.J.*, 1958, **60**, 102-103.

✤ HILLESHÖG
for the highest quality seed

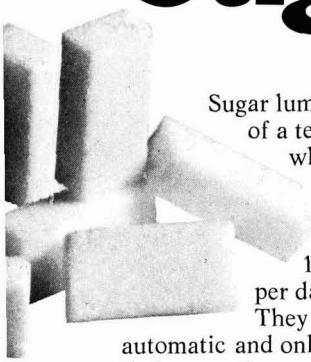
The Hilleshög seed emanates from crops grown under strict supervision in most suitable seed growing areas and are, therefore, of the highest possible quality. The high germinations ensure vigorous early growth, leading to maximum plant establishment in the field, which contributes to the optimum yield of sugar.

HILLESHÖG FOR CONTINUING PROGRESS

Our extensive breeding and genetic research programmes aim to provide varieties which are adaptable to local conditions, thereby giving all growers the chance to select a variety which is suitable to their own particular use. Hilleshög sugar beet seed is available wherever commercial beet is grown, either through the sugar factories or local agents.

Hilleshög Aktiebolag
S-261 23 Landskrona,
Sweden

Sugar in lumps. A



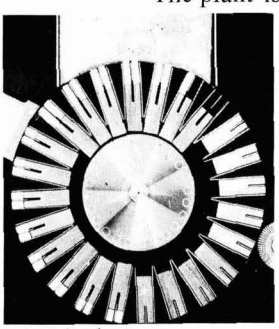
Sugar lumps are at present produced throughout the world by means of a technique perfected and modernised by MACHINES CHAMBON, who today offer entirely automatic lines for the moulding and conditioning of sugar lumps of all sizes.

The CHAMBON plants mould, dry and put into boxes according to type, 12, 24, 55, 80 or 100 tons* of sugar per day.

They are strongly built, reliable, completely automatic and only a few people are required to supervise their operation.

PLANT	PRODUCTION/24 h
EMR	12 or 24 t
1 DM	55 t
1 DMH	55 t
3 DM	100 t
4 DM	80 t (hard sugar)

A rotary moulding unit.



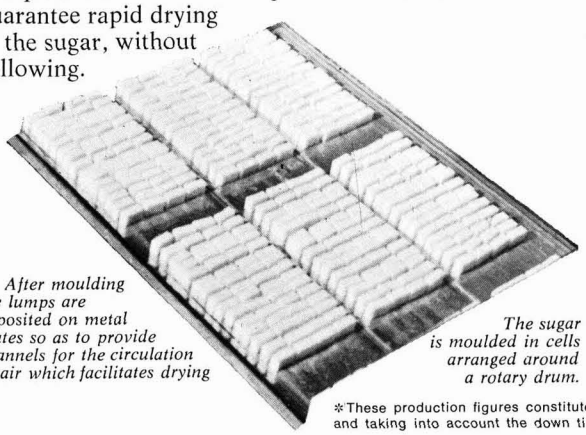
The plant is supplied with dry or humid sugar. Suitably mixed so as to be perfectly homogeneous, the sugar is fed evenly into moulds spead out around a rotary drum. The dimensions of these moulds vary according to whether one wishes to produce lumps of sugar of size 3, 4 or 5 or cubes.

A system of compression by mobile pistons produces lumps perfectly regular in shape and weight and of variable hardness according to the rate of compression.

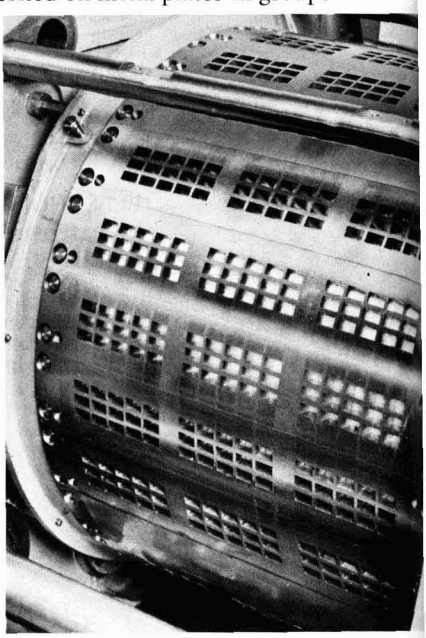
Rapid and perfect drying.

After moulding, the lumps are deposited on metal plates in groups corresponding to one horizontal layer (1/3 kg) of the finished box. The lumps are arranged to provide channels for the circulation of air which facilitates drying.

Driven by an endless chain, the plates are carried into a vertical or horizontal drying unit according to the power of the plant. The relatively low temperature, the good distribution of the air heated by low-pressure steam and the permanent renewal of this air guarantee rapid drying of the sugar, without yellowing.



After moulding the lumps are deposited on metal plates so as to provide channels for the circulation of air which facilitates drying



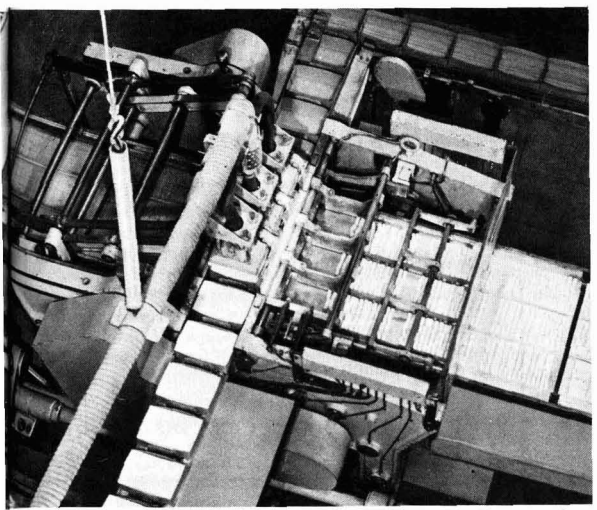
The sugar is moulded in cells arranged around a rotary drum.

*These production figures constitute minimum tonnages guaranteed under normal operating condi and taking into account the down time for weekly cleaning.

simple product.

Automatic conditioning.

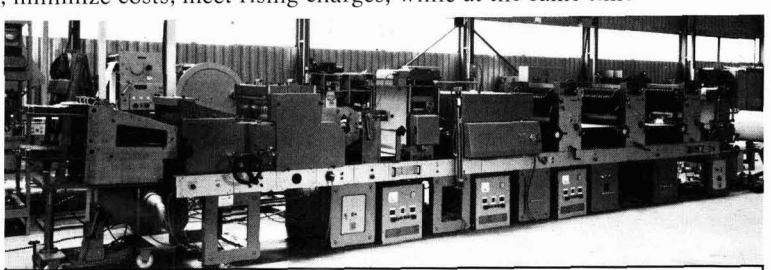
On leaving the drying units, the lumps are gathered and deposited by pneumatic fingers in three successive layers in the boxes, which are formed on a connected machine and automatically supplied to the conditioning line.
The full box is conveyed to the closing machine, which forms and glues the lid of the box.



A well-designed production unit.

A moulding and conditioning unit comprises certain basic inseparable elements synchronised with each other, all the functions of which are automatic, and optional elements (such as the machine for printing and forming the lids or the one-piece boxes, and the machine for parcelling in packets of 5 or 10 boxes).
Entirely automatic, it allows the production of 500 to 4,500 boxes of 1 kg per hour, according to the unit, without any manual intervention.
Four persons are sufficient to supervise all the operations.

To increase production, minimize costs, meet rising charges, while at the same time ensuring the supply of a product of exceptional quality, it is necessary to have automatic equipment, designed and manufactured by specialists. It is therefore not by mere chance that more than 95 % of the world production of lump sugar is carried out on CHAMBON plants. Today, more than 150 CHAMBON plants throughout the world each produce from 12 to 100 tons of moulded and packed sugar per day.



The boxes are printed and formed in a single operation.

CHAMBON

Bergère/Communication

France 6, rue Auguste-Rodin - La Source B.P. 6329 - 45063 Orléans Cédex. Tél. (38) 63.20.74. Télex Chambon 760 763
Great Britain Riverside Works, Standish Road Hammersmith - London W.6. 9AN. Tel. 741.04.41. Telex 261476
U.S.A. 24 North Third Avenue, Highland Park, New Jersey 08904. Tel. (201) 846 8010. Telex 0844445
Brazil Rua Um S/N° - Distrito Industrial Caixa Postal 38 - 94900 Cachoeirinha RS Tel. 70. 1789 - 70.1922 70.1821 Telex 512071
Singapore 2107, 21st Floor - Golden Mile Tower - 6001 Beach Road - Singapore 0719. Tel. 2931007. Telex 34447

formula of Carruthers & Oldfield[4] (0.0975K + 0.0805Na + 0.140 amino-N in which K, Na and amino-N are the number of milliequivalents of potassium, sodium and amino-nitrogen per 100g sugar measured in a lead polarization digest).

Emergence

Speed of emergence and establishment are assessed in trials but more accurate records of varietal behaviour are obtained from additional tests at six centres where known numbers of seeds of each variety are drilled. As different seed units on the drill may influence emergence, care is taken in the design of these trials to ensure that each variety is represented by a different unit in each replicate of a trial. Counts are made when about 20% seedlings have emerged and when emergence is deemed complete.

Bolting

Bolting is recorded in the variety trials and counts are made on the three dates during the season: late June, late July and at harvest. The first count in June monitors possible annual beet content, the July count indicates varieties with a tendency to bolt early, while the harvest count will give total bolter numbers for assessment of relative susceptibility.

However, routine variety trials have limitations for assessing susceptibility to bolting as little bolting may occur in some seasons when sown at a normal time; this has become more of a problem with the improved standards of bolting resistance exhibited by current varieties. Accordingly, additional variety plots are sown as early as possible in unreplicated trials in 15 British Sugar Corporation factory areas. As Corporation staff are in regular communication with growers, they are able to approach growers sowing very early in the season. One grower in each factory area is persuaded to undertake to sow the Early Sown Bolter Plots in March (although for the first time in 25 years experience of this work, only 2 sites were sown in March 1979 owing to the exceptionally late spring).

Virus yellows

Although recording of the symptoms of infection with virus yellows can be relatively straightforward, the symptoms do not necessarily indicate yield loss or tolerance of infection. These are studied in separate trials at two centres in which the performance of varieties artificially inoculated with a mixture of Beet Yellows Virus and Beet Mild Yellows Virus, by transfer through viruliferous aphids, is compared with a control treatment using aphicides to prevent natural infection.

Trials are also sown at two other sites in an area where virus yellows is common and yield assessments normally show the relative performance of varieties when subjected to natural infection.

Downy mildew

Downy mildew (*Peronospora farinosa*) has not been a serious problem in the UK commercial crop for 15 years but varietal reaction is assessed because of the potential threat to the economics of beet growing as there is no proven control. As the disease is infrequent, records from the routine variety trials are inadequate and reliance is therefore placed on a trial at the NIAB Regional Trials Centre grown in Wales, where the disease is introduced artificially, well away from the commercial crop. Varietal susceptibility ratings are obtained from these trials. For a fee, the Institute offers British breeders the opportunity to grow breeding material for inoculation alongside the trials to facilitate selection for resistance.

Other diseases

The principal diseases recorded in varietal trials, in addition to virus yellows and downy mildew, are powdery mildew (*Erysiphe betae*), leaf spot (*Ramularia beticola*) and rust (*Euromyces betae*). Incidence is often low and supplementary records are obtained from observation plots grown at two sites in an area where disease attack is more frequent.

NATIONAL LIST OF SUGAR BEET VARIETIES

A UK National List of varieties which can be marketed is required under an EEC directive which specifies that, before acceptance for marketing, a variety must be established as "satisfactory for cultivation and use" and must comply with criteria for "distinctness uniformity and stability". Varieties on the National Lists of Member States are normally listed together on the EEC Common Catalogue and such varieties may be marketed anywhere in the EEC.

However the National List should not be confused with the Recommended List which is used extensively by growers. Varieties which are not recommended are not grown on any scale because seed is not freely available from the British Sugar Corporation, although growers could grow them on a proportion of their acreage if they so wished and could obtain seed. Breeders submit new varieties in the first place for addition to the UK National List. New varieties are tested in Preliminary Trials at seven centres in the first year and in Main Trials at 17 centres in the second and third years, to determine whether a variety is satisfactory and to identify any major fault.

The assessment of distinctness, uniformity and stability is difficult given the lack of morphological characters which provide the essential data in other crops. A basic classification is made on germity and ploidy but it is necessary to resort to the performance and quality data derived from the performance trials to establish distinctness. Distinctness is established if a variety is shown to be significantly different at the 5% probability level for one or more characters in at least two of the three years[5]. The characters used are sugar content, total impurities, sodium, potassium, amino nitrogen, root yield, top size, average root weight and, with reservations, incidence of bolting. Although a gross lack of uniformity would be unacceptable, some variability is inevitable as entries are generally synthetic varieties.

Stability is difficult to assess in a biennial crop in only three years other than to note the occurrence of major changes. In any case, some changes are likely to occur in the maintenance of a sugar beet variety and this has to be allowed for.

RECOMMENDED LIST OF SUGAR BEET VARIETIES

The Recommended List is a short list of varieties chosen for their good trial performance and is issued by NIAB in an advisory leaflet for farmers. The same three year results used for National List purposes are reviewed by an Advisory Committee appointed by the NIAB Council (or governing body). The Committee consists of sugar beet experts representing farmer, adviser, research

[4] *Proc. XI Session C.I.T.S.*, 1962, 224.
[5] *J. Nat. Inst. Agric. Bot.*, 1974, 13, 244-251.

and processor interests. Institute staff advise the Committee but are not directly involved with decision making.

Varieties that have been accepted for the National List are considered for the Recommended List but the requirements for Recommendation are more critical. Varieties recently added to the Recommended List (Table II) are listed under a separate heading: "Grown in trials for a shorter period", indicating that further trials and commercial farm assessment are required to confirm the early promise. Seed supplies are likely to be limited at this stage and growers are normally cautious in changing to new varieties.

series at 17 sites, with the preliminary varieties included at 7 only. This amalgamation, which has been facilitated by the use of the incomplete block design, has proved economical in avoiding the duplication of control varieties that occurred in separate trial series and, furthermore, ensures a common basis on which to compare varieties in the different trials.

The inclusion of Recommended varieties in trials each year provides an opportunity to monitor performance and the results are incorporated in three year summaries (Table II) published in the NIAB Farmers' Leaflet 5 and updated annually. The results are considered in more detail in an annual review of the trials published in the *British Sugar Beet Review*, which is distributed to all

Table II. Recommended list of sugar beet 1980-81

Variety	Year first listed	Relative yield: Sugar %	Relative yield: Sugar Tonnes per hectare	Relative yield: Roots %	Relative yield: Roots Tonnes per hectare	Quality: Sugar content %	Quality: Measured impurities per 100S	Bolters per 100 plant positions: Normal sowing	Bolters per 100 plant positions: Early sowing	Size of top 0 = very small 9 = very large	Resistance to downy mildew 0 = very low 9 = very high	Emergence % Emergence in field trials
Amono	1966	99	8.31	99	47.5	17.6	4.88	0.1	1.7	5	5	58
Bush Mono G	1973	97	8.20	99	47.4	17.4	4.83	0.4	3.1	7	6	64
Hilleshog Monotri	1966	101	8.48	100	47.8	17.8	4.86	0.4	3.1	3	5	60
Nomo	1974	100	8.45	102	48.8	17.4	4.94	0.1	1.0	5	3	66
Sharpes Klein Monobeet	1969	97	8.20	99	47.3	17.4	4.86	1.2	5.9	7	4	61
Vytomo	1974	97	8.14	97	46.3	17.6	4.52	0.1	1.5	5	2	64
Grown in trials for a shorter period												
Amazon	1980	100	8.45	101	48.4	17.5	4.80	0.2	2.1	5	5	65
Monoire	1979	104	8.76	103	49.4	17.8	4.83	0.1	0.8	4	6	60
Salohill	1980	104	8.78	101	48.3	18.3	4.53	0.5	2.8	5	2	68
Mean		100	8.42	100	47.9	17.6	4.78	0.3	2.4	-	-	63

If the performance of a variety appears to falter, for whatever reason, or is surpassed by other varieties, the breeder is given warning that it will be considered for removal from the List in three year's time. This warning is given confidentially, to give the breeder an opportunity to improve varietal performance before a final decision is made. Exceptional cases have occurred where, because of a marked deterioration in performance, a variety has been deleted from the List without this warning procedure.

The quality of a variety is considered inadequate if, on the basis of the three year average results from NIAB trials, a variety differs from the mean of the Recommended general purpose varieties in respect of sugar content and impurity by any of the following amounts, measured in terms of standard errors of a variety mean:

(a) sugar content – more than 4.0 standard errors below the mean.
(b) impurity (using the Carruthers and Oldfield formula quoted above) – more than 5.0 standard errors above the mean.
(c) general quality – by more than 6.0 standard errors. This is assessed by adding the number of standard errors by which the sugar content is less than the mean to the number of standard errors by which the impurity is greater than the mean.

Mention has already been made of possible changes in performance characteristics of a variety during reselection and multiplication. These changes can operate to the advantage or detriment of the grower and it is therefore essential that all Recommended varieties are tested every year in a trial series for commercial varieties. Originally the Preliminary and Main trials of new varieties and these Commercial Variety trials were each grown as separate series but they have now been combined into one trial

growers. Publication in this way puts pressure on the breeder and seed producer to maintain the highest standards.

In order to ensure that the results for a variety bear a relationship to performance of the commercial crop, the seed of the commercially available varieties used for trials is obtained from samples of the seed used by growers. The British Sugar Corporation samples and tests all seed lots each year prior to distribution of seed to growers and seed of a particular variety for trial will consist of a blend of these samples, the amount of each sample being representative of the proportion of the different lots distributed to growers. This method ensures that the trial seed fully represents that delivered to growers in the year of trial.

Checks on commercial seed

As explained above, seed used for Commercial Variety trials is derived from a blend of samples from the different seed lots being distributed to growers, but the individual samples are also tested separately. They were until recently included in Seed Stock Trials at two centres in which yield and root quality were assessed as in the variety trials. These trials were very effective in monitoring field emergence and bolting but proved expensive and inconclusive in establishing differences between stocks in general performance. They have been replaced with two trial series designed to monitor emergence and bolting separately.

These special Emergence Trials are grown at four centres and include all seed lots distributed to growers in the year of trial. Known numbers of seeds are drilled at the same time as the commercial crop and assessment is made in the same manner as the variety Emergence Trials described above.

The same seed stocks are sown in late May at another six sites; large plots of about 2000 plants are sown to assess bolting. Since the time of drilling is normally too late for low temperature-induced vernalization, any bolters appearing are likely to be annual beet and this trial series has been an important factor in the campaign to eliminate weed beet as a seed contamination problem in England.

When any problem, relating to a particular seed stock, in either the emergence or late-sown bolter plots, is identified, the breeder and the British Sugar Corporation are alerted so that action can be taken to identify the source. In practice this has involved the disposal of remaining seed of problem stocks, so these additional tests provide an important safeguard to the grower.

Role of NIAB

The program of work on sugar beet undertaken by NIAB represents an excellent example of co-operation between all sections of the industry. The Institute undertakes the National List work under contract to the Ministry of Agriculture, while the rest of the work is financed by the Sugar Beet Research and Education Committee with funds contributed by growers and processors. Trials are grown at seven Regional Trial Centres in the sugar beet growing area, supervised by resident Institute staff, and other trials are organized with the assistance of BSC: the Corporation provides assistance in the field and laboratories services. Breeders inspect the trials regularly and report to the Institute, while growers provide sites for the work and many take a close interest in developments. Institute staff are responsible finally for the analysis of results and for the presentation of reports on seeds and varieties which provide the basis for good crops.

Summary

An account is given of the co-operative procedures employed in England for the testing of new sugar beet varieties prior to marketing and the checking of commercial varieties in order to ensure that beet farmers receive good quality seed.

Essais de variétés de betteraves sucrières en Angleterre

On expose les méthodes en coopération utilisées en Angleterre pour l'essai de nouvelles variétés de betteraves sucrières avant le marketing et pour le contrôle des variétés commerciales en vue d'assurer aux planteurs de betteraves l'obtention de graines de haute qualité.

Zuckerrübensortenversuche in England

Eine Übersicht über kooperative Verfahren wird gegeben, die in England zum Testen von neuen Zuckerrübensorten vor dem Marketing und zum Prüfen von kommerziellen Sorten angewendet werden, um den Rübenbauern die Versorgung von Samen hoher Qualität abzusichern.

Prueba de variedades de remolacha azucarera en Inglaterra

Se presenta un examen de los tramites cooperativos empleado en Inglaterra para la prueba de nuevas variedades de remolacha azucarera antes de venta y el control de variedades comerciales para asegurar a los granjeros una semilla de buena calidad. □

Sugar beet breeding

By DR. S. ELLERTON

Other crops have been improved over thousands of years by cultivators, often aided by natural selection, but sugar beet is different. The beet sugar industry only began at the end of the 18th century and, to develop the plant into an efficient, profitable crop in so short a time has required extreme expertise and specialized scientific methods. The range of breeding techniques employed on the crop is greater than for any other, and it is not at all certain what is likely to prove the most successful method in the future.

Clearly the main requirement for any crop is high yield. In the case of sugar beet, this means maximum *extractable* sugar per acre which is a rough measure of the value of the beet as an industrial raw material. Very large beets are low in sugar, while very high sugar contents are only found in smaller roots, so that, a compromise has to be found. Certain impurities affect sugar extraction at the factory; of these, potassium, sodium and amoninitrogen are the most important and they all show genetic variability.

Until recently, growers in many countries have been paid for their beets on gross sugar per acre only. While the breeder has a regard for the factory, the grower is his customer! Breeding for high purity therefore becomes an expensive and often thankless public relations exercise unless the grower is duly recompensed for producing good quality.

Fortunately, new automatic analytical equipment and the rationalization of impurity calculations by Carruthers & Oldfield in the UK have made it practical for more and more sugar companies to assess beet purity as a component of growers' payments.

Sugar beet is a biennial and odd roots which bolt in the first year are a source of loss, so that freedom from bolting is a second objective for breeders. The genetics of this characteristic are complex and there is a practical limit to bolting resistance, in that the crop must not be so resistant as to be incapable of bolting in the second year as a seed crop.

Dr. S. Ellerton

Bolting in lower latitudes is not a problem except where beet is sown in the autumn.

Sugar beet is much less vulnerable to disease than many crops, as varieties are not composed of single genotypes, but are populations with great genetic diversity. Nevertheless, for European conditions, undue susceptibility to such diseases as virus yellows and downy mildew must be avoided. A positive resistance to or tolerance of any or all of these diseases would be regarded as an asset, but only if obtained without a significant loss of yielding ability. Curly-top virus can devastate crops in parts of the United States and Cercospora leaf spot is important in the relatively warm and moist parts of the world. In the latter case there is often a preference for chemical control of the disease in susceptible varieties rather than the growing of resistant varieties of reduced yielding ability. Other diseases are of breeding importance in some areas.

One of the most important revolutions in the development of the crop has been the conversion of varieties to the monogerm condition. This has been an essential pre-requisite to spring mechanization, and sowing to a stand is now widely practised.

When beet seed was sown thickly in rows, there was strong competition between emerging plants prior to singling. As the hoeman would tend to leave the stronger plants, a significant improvement in yield resulted as compared with random singling.

Sowing monogerm varieties to a stand requires not only near-perfect germination, but nearly every plant must be equal to the *best* of the multigerm plants after competition in the field and selection by the hoe.

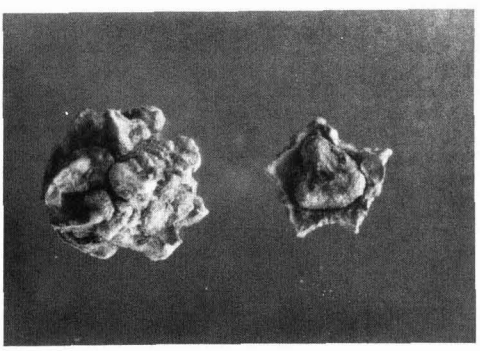


Fig. 1. Monogerm and multigerm sugar beet seed

Part of this objective has been attained through breeding and seed processing techniques, and part has been due to the monogerm gene itself, leading as it did to larger embryos.

Selection of varieties after intensive germination tests has been augmented by cold emergence testing, which is in many ways a more realistic approach.

Seed processing followed by gravity separation to remove empty or weak embryos can markedly improve germination and vigour with little loss. However, as competition between varieties becomes tougher, these techniques are pushed further and further towards the limit, with the result that more and more good seed is lost.

The best quality seed must therefore be expensive to cover breeding costs and processing losses. This does not affect the farmer, however, who might pay more per pound of seed but who uses less and less to plant an acre. Sugar beet is still a very cheap crop to sow on a per-acre basis.

Mass selection

From the beginning, sugar beet breeders have selected apparently superior roots from varietal populations and have grown them on for seed in the hope of producing a superior variety. This procedure became much more effective when the progeny test was invented and when instruments became available for the rapid estimation of sugar content and, much later, of important impurities. Modern field trial techniques and design and computerized data handling further enhanced the method and in their latest and most developed forms such methods are still of great importance.

Few if any commercial varieties are so bred today, but the method is used to develop "feeder populations" for breeding schemes. Such populations might be intended for use as ultimate pollinators for variety production, or as high-yielding or high-quality breeding sources. They might be selected for disease resistance or for any other character which is considered relevant. As will be seen later, they may have a doubled chromosome number or otherwise have been radically changed in the pursuit of modern breeding methods.

Hybrid breeding

What is usually implied by the word "hybrid", nowadays, is a form of repeatable controlled pollination aimed at the consistent and repeated production of a particular cross. This requires inbreeding to obtain genetic uniformity, followed by crossing to restore hybrid vigour. Sugar beet is a most difficult plant to handle in this way. Producing hundreds of small flowers on each plant, each of which has the necessary female parts plus five tiny stamens, it is an unlikely candidate for the production of inbreds.

Fortunately, F. V. Owen in the United States discovered a form of male sterility in sugar beet, cytoplasmically inherited. Sterility could be passed from mother to offspring, enabling breeders to carry out large-scale crossings between a fertile and a male-sterile plant.

There were two major obstacles to be overcome before this method could be utilized. First, genes known as restorers were found to be widespread in sugar beet and these genes overruled the transmission of cytoplasmic sterility. Breeders therefore had to carry out widespread searches through beet populations to discover occasional plants (O-types) which did not carry such genes. There was no way of identifying such plants except from their breeding behaviour, so that the search was laborious and slow. Second, an essential part of the hybrid method of breeding was the production of inbreds in large numbers, with subsequent testing of various crosses between them.

Sugar beet is normally self-sterile, or nearly so, so that inbreeding by self-pollination often failed completely and, at best, only a few seeds could be expected. In such inbreeding programs, contamination became an important problem, since sugar beet plants would be all too liable to pick up stray pollen grains from outside sources.

Normal sugar beet is a great producer of pollen, capable of travelling long distances, so the danger of unwanted crossing was very real.

Acceptable solutions have been found and most modern commercial varieties are hybrids produced by crossing a cytoplasmic male-sterile with an appropriate pollinator.

A self fertility gene has been incorporated into O-type material to facilitate inbreeding and reduce accidental contamination. This in turn has posed another problem, of how to cross self-fertiles together to obtain

gene recombinations. Here, another form of male sterility, also discovered by Owen, is used, which is determined by a normal gene. This can be built into a population when required and afterwards be readily removed.

The pollinator

Commercial variety pollinators are the product of quite separate breeding schemes. Normally it does not take the form of an inbred line or an F_1 hybrid between two such lines but rather some form of selected population, which gives a broader genetic base to the variety.

Sugar beet is actually exceptional in the extent that one variety can perform well in quite different parts of the world. In spite of this, some breeders seek better performance by selecting specific adaptations to local environments.

In advanced countries, all research is directed to the production of genetic monogerm varieties. Some multigerm breeding still continues as most pollinators are multigerm, enabling controlled crosses to be produced in the seed field by growing the two parents together as a mixture. The complete crop is then harvested and the pollinator can then be separated out by screening, owing to the difference between size and shape of the seed of the two parents.

Polyploidy

The pollinator of a modern variety is thus wide based, but still subject to intensive breeding.

At this point there is an important option. The pollinator may have a normal chromosome number (diploid) or it may be tetraploid, the product of chromosome doubling induced by colchicine.

Tetraploid multigerm material formed the basis of the old "polyploid" varieties, more properly known as anisoploid. Now, with controlled pollination arising from the use of male-sterility, the breeder may choose between a diploid hybrid and a triploid, (diploid X tetraploid).

There is a great deal written about the differences between diploid, triploid and tetraploid sugar beet, most of it not at all critical. In actual fact their relative merits are not clear in any general sense, and there would appear to be room for both diploids and triploids.

Triploidy is not a magic word, but some of the best modern varieties are indeed triploid.

The development and use of tetraploid parents is extremely costly, requiring, for instance, routine chromosome counting on tens of thousands of plants.

This résumé of breeding methods is not complete. There are other options, some of which are being actively pursued, but the methods described give background to the nature of most important present-day varieties. In this competitive field we may be sure that we are nowhere near the end of the road, either in inventiveness or in the performance of varieties.

What is certain is that the work, if it is to have a good chance of success, must be very large in scale. In fact, the chance of assembling the ideal set of genes into one variety is exceedingly remote.

The numbers game

As an example, suppose we start with the character, "gross sugar yield". In order to produce useful improvement the breeder may identify the best 1% of his population on, say, the pollinator side. He can only do this by running yield trials and these are subject to experimental error. Hence, if the best 1% are taken, many of them will assuredly not be superior; rather they will have been lucky. So more replications, repeat trials in several locations for more years, alone can prove he has a useful starting point.

Fig. 2. More than 2000 isolators over pairs of plant in a population improvement scheme

This is only the beginning; it is no use improving yields if juice purity is unacceptable, roots are misshapen, or the line shows poor germination, easy bolting or susceptibility to disease either as a root crop or in the seed crop.

Every requirement brought in means rejection of some selections and hence a slower advance in all the other characters. This is the main reason why breeding for disease resistance almost always leads to a slower rate of progress in yielding abilities.

Similar testing and elimination must take place on the female side, so that the trial program which aims at a good probability of success must be enormous, as must the mass of data which has to be handled by that invaluable tool, the digital computer. Any single sugar beet breeder will handle far more trial plots than all the official variety testing organizations in Europe.

It can be readily seen that breeders are unlikely to be out of business in the forseeable future-collectively, that is. The business is brutally competitive and extremely expensive, so that the less successful cannot survive for long.

Such competition must, however, be the best way of achieving rapid advances and is surely in the best interests of the industry as a whole.

Summary

The author summarizes and discusses the criteria employed in breeding of sugar beet. He describes the older mass selection method and the newer techniques of hybrid breeding, particularly of genetic monogerm seed. He indicates that the importance of level ploidy may be less than has been written earlier. The complication of selection to meet the need for numerous characters which must be acceptable is described, with mention of the use of the invaluable digital computer.

La sélection de betteraves sucrières

L'auteur donne un aperçu des critères employés dans la sélection de betteraves sucrières et les dicutent. Il décrit la plus ancienne méthode de sélection en masse aussi comme les plus modernes techniques de sélection d'hybrides, particulièrement de graines monogermes, génétiques. Il indique que l'importance de la ploidie dre peut être moin que celle attribuée auparavant. La complication de la sélection pour satisfaire aux besoins des nombreux caractères, qui doivent être acceptables, est décrite, avec mention de l'emploi de l'inestimable digital.

Zuckerrübenzüchtung

Vom Verfasseer werden die bei Zuckerrübenzüchtung angewendeten Kriterien kurzgefasst und diskutiert. Er beschreibt die frühere Massenauslese-Method auch die neueren Hybridzüchtungsmethoden, insbesondere für Herstellung von genetischen Monogerm-Samen. Er ist der Meinung, dass die Bedeutung von Ploidie sei geringer als früher beschrieben. Die Verwicklung der Selektion um die nötigen zahlreichen Merkmale zu liefern, die annehmbar sein müssen, wird beschrieben, mit Erwähn der Anwendung des unschätzbaren ung Digitalrechners.

Crianza de remolacha azucarera

El autor resume y discute los criterios empleado en la crianza de remolacha azucarera. Describe el método más antiguo de selección de una masa y las más modernas técnicas de crianza de híbridios, especialmente de semilla geneticamente monogermenal. Indica que la importancia de ploidez puede ser menos que comunicado antes. Se describe la complicación de seleccipn para satisfacer las necesidades para numerosas características que deben ser acceptables, con mención del uso de computador digital inestimable.

Czechoslovakia sugar exports[1]

	1977	1978	1979
	tonnes, raw value		
Algeria	6,315	30,130	48,752
Belgium	108	0	87
Cameroun	0	0	109
Cyprus	0	0	1,630
Germany, West	1,059	2,209	2,889
Holland	0	170	536
Hong Kong	0	0	217
Iceland	0	451	98
Indonesia	25,107	0	0
Italy	43	1,262	109
Jordan	2,173	45,680	0
Kenya	11,717	0	0
Lebanon	4,826	5,092	4,348
Norway	2,317	3,936	1,223
Rumania	0	0	11,957
Saudi Arabia	110,949	162,930	130,859
Singapore	0	2,609	435
Sri Lanka	4,598	5,185	0
Sudan	0	22,826	0
Switzerland	1,457	0	0
Syria	0	17,120	0
USSR	0	0	39,130
Yemen, South	0	5,429	0
Other countries	65	1,072	98
	170,734	306,101	242,477

Guyana sugar expansion[2]. — Guyana's sugar production target is 335,000 tonnes in 1980 against an output of 298,000 tonnes in 1979 when the target was not reached owing to bad weather.

Belgium sugar factory closure[3]. — The sugar factory at Liers, at a slicing capacity of 1300 tonnes per day the smallest in the EEC, has been closed. It had processed about 100,000 tonnes per campaign to produce raw sugar which was mainly sent to West Germany.

Kenya alcohol distillery[4] — A new molasses alcohol plant, Agro-Chemical and Food Co., is to be built at Muhuroni in Nyanza province at a cost of 222 million shillings (approx. £13 million). The project is a joint venture of the Industrial & Commercial Development Corporation and Vereinigte Edelstahlwerke AG of Austria, and will be managed by the Mehta Group of Companies. The plant, to be commissioned in 1982, is expected to produce 2.5 million litres of industrial alcohol and 15.5 million litres of power alcohol annually in addition to 1154 tonnes of active dry baker's yeast. These will require some 64,000 tonnes of molasses per year. It is estimated that the use of power alcohol from the plant will save the country between 12 and 18% of its present oil import bill.

Guadeloupe sugar factory closure[5]. — The Darboussier factory of Société Industrielle de Sucrerie near Point-à-Pitre has been closed, leaving only five factories in operation in Guadeloupe.

Thailand sugar production, 1979/80[6]. — The latest estimate shows that a total of 12,790,000 tonnes of cane was grown in the 1979/80 crop against 20,240,000 tonnes in 1978/79. A total of 1,033,366 tonnes of sugar, tel quel, was produced, made up of 518,895 tonnes of white sugar and 514,471 tonnes of raw sugar. This compares with 514,000 and 1,280,000 tonnes, respectively, for the previous crop, the sharp decline in sugar production being due to drought in the previous crop year.

India sugar statistics[7]

	1979		1978	
	tonnes, raw value			
Initial stocks		3,053,142		1,849,862
Production		6,117,000		7,102,694
		9,170,142		8,952,556
Consumption		6,650,690 *		5,211,940
Exports				
Afghanistan	0		10,804	
Bangladesh	17,773		0	
China	33,494		76,873	
Djibouti	0		1,405	
Egypt	87,406		46,999	
Indonesia	206,691		273,669	
Kenya	44,568		0	
Korea, North	0		33,278	
Maldives	4,375		2,592	
Mali	1,215		0	
Pakistan	21,176		0	
Somalia	23,067		0	
Sri Lanka	300,197		91,999	
Sudan	12,965		76,278	
Tunisia	0		11,128	
UK	27,525		25,714	
Yemen, South	0		36,735	
		780,452		687,474
Final stocks		1,739,000		3,053,142

* Calculated; figure given is 6,758,000 tonnes.

Peru sugar shortage[8]. — Peru is to import 70,000 tonnes of sugar this year; it has fallen short of its quota obligations under the International Sugar Agreement by about 100,000 tonnes, compared with its quota in effect of 280,023 tonnes, and has been unable to maintain its special stock obligations. The sugar cooperatives have been requesting a 70% price increase but this has been refused by the Government which has instead decided to make weekly subsidies to the industry.

New USSR sugar factory[9]. — A new sugar factory was constructed in 1979 at Dobrinka in Lipetsk oblast, bringing the total of beet sugar factories in the Soviet Union to 323.

USSR sugar crop target reduction[10]. — According to the US agricultural attaché in Moscow, the USSR has lowered its 1980 beet sugar production target from 9,108,000 to 8,995,000 tonnes. The revised figure is possibly the result of difficulties in sugar beet sowing in 1980 which has been reported as even later than the badly delayed sowing of the 1979 crop.

1 *I.S.O. Stat. Bull.*, 1980, **39**, (3), 31.
2 *Reuter's Sugar Newsletter*, April 11, 1980.
3 *Zuckerind.*, 1980, **105**, 517.
4 *Standard Chartered Review*, May 1980, 13.
5 *Zuckerind.*, 1980, **105**, 518.
6 *Standard Chartered Review*, May 1980, 35.
7 *I.S.O. Stat. Bull.*, 1980, **39**, (3), 50.
8 *Bank of London & S. America Review*, 1980, **14**, 140.
9 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 273.
10 *Lamborn*, 1980, **58**, 68.

SUGAR CANE AGRONOMY

ICAR All-India Coordinated Research Project on Sugar Cane – Technical Report for the year 1977-78. Anon. *Maharashtra Sugar*, 1979, **4**, (3), 9-59; (4), 9-48. – Research work organized and coordinated by the Indian Council of Agricultural Research is carried out all over the country. The present report summarizes the huge volume of work in a large number of fields of interest, including agronomic techniques, weed control, planting, fertilizer trials, soil moisture studies, etc.

Irrigation's important role in the sugar industry. Anon. *Australian Sugar J.*, 1979, **70**, 515-516. – Almost 40% of the cane area of Queensland is irrigated, and an analysis is presented of the areas within the state, sources and systems, etc.

Irrigation in sugar cane. A. P. Sousa, G. E. Serra, R. Scardua and F. A. D. Conceição. *Brasil Açuc.*, 1979, **92**, 344-350 *(Portuguese)*. – Irrigation experiments on a structured red soil using two cane varieties are described. Cane and sugar yields were increased on average by 45% with application of 1450 mm of water, well distributed in the various months of the experiments. With application of fertilizer in greater quantities (40:120:150 kg. ha^{-1} of $N:P_2O_5:K_2O$) the frequency of irrigation could be reduced; thus, maintenance of a minimum potential of −1.4 bar, corresponding to a minimum level of 23.27% soil moisture, resulted in higher yields of cane and sugar.

A résumé on chemical ripening of sugar cane. A. Ali. *Indian Sugar Crops J.*, 1979, **6**, 8-12. – The literature on cane ripening with chemicals is reviewed.

Sugar cane irrigation. II. Effects on production, technological characteristics and mineral elements in the juice. A. P. Sousa, G. E. Serra and P. R. Leopoldo. *Brasil Açuc.*, 1979, **94**, 31-34 *(Portuguese)*. – Irrigation was applied to a structured terra roxa soil under three regimes of different potential (I_1, I_2 and I_3) which resulted in total of 2 x 31 mm = 62 mm, 9 x 21 mm = 189 mm, and 17 x 10 mm = 170 mm of water, respectively. The weight of tops produced was the only factor to be increased significantly. Only very small variations were found in juice Brix and pol, P_2O_5, K_2O, CaO, MgO and SiO_2 contents.

Problems of control of sugar cane weeds in the world. R. A. Arévalo. *La Hacienda*, 1979, **74**, (1), 43-44 *(Spanish)*. – The most serious weeds occurring in cane fields are listed and the losses in potential cane yield in different continents tabulated. Control is best in the developed countries and, in developing countries, on farms or estates of larger area which are more economically and more efficiently run. Use of modern techniques reduces the cost of herbicide application per unit area and it is a challenge to society to establish projects for adoption of control measures in order to reduce losses and give social benefits such as liberation of children from weeding to enable them to attend school.

Water requirements of the sugar cane. J. Charoy, F. Forest, J. C. Legoupil and D. Bassereau. *Agron. Trop.*, 1978, **33**, 344-369 *(French)*. – Cane water requirements were calculated at stations representative of different climates, viz. in the Ivory Coast, Madagascar, Niger, Réunion and Martinique. The applicability of a mathematical model of water balance for calculation of a cane irrigation project is indicated for a region of Togo; the model includes rainfall, type of soil (in terms of effective water reserve), optimum water application period, crop requirement and evapotranspiration. The model can have numerous applications in irrigation research and case studies.

Aerial spraying of nitrogen (urea) to increase the yield of sugar cane ratoons. J. D. Chougule. *Maharashtra Sugar*, 1979, **4**, (5), 41-42. – Trials are reported in which comparison was made between soil application of urea at 119.09 kg $N.acre^{-1}$ and part soil and part foliar application of the same total quantity but in different proportions. Results showed that best, in terms of mean mature height, girth of cane stalk and number of internodes, was soil application of 107.72 $kg.acre^{-1}$ with the rest applied as foliar spray.

Natural forces and sugar crop production. J. R. Orsenigo. *Sugar y Azúcar Yearbook*, 1979, **47**, 59-78. – The author, Director of Research of the Florida Sugar Cane Leagure, surveys factors affecting cane and beet crop growth, most attention being concentrated on cane. The factors are grouped under climate, soil and crop nutrition, diseases, pests and variety; 90 references are given to the literature.

Variability of the criteria of sugar cane *(Saccharum officinarum)* yield. N. Milanes R. *Informe Cient.-Técn. Inst. Invest. Caña Azuc.* (Acad. Ciencias de Cuba), 1978, (49), 8 pp *(Spanish)*. – Comparison of new varieties of cane is based on crop yield and recoverable sugar, and a study was made over a 7-year period to determine the size and optimum number of cane samples to be taken for sugar analysis under conditions in Cuba, and to establish a method of estimating yield in test plots other than harvesting all of the cane. It was concluded that random sampling of stalks within the plot was more representative of the variability of population than with complete plantings. For weight and sugar determinations, four samples of five stalks should be taken from each plot. The best method of estimating crop yield is to count the stalk population in two rows, one internal and one external, and to weigh a sample of 20 stalks from the whole harvestable area.

Flowering in sugar cane: results of 2 years' experience. C. A. Levi, J. A. Mariotti and C. G. Arévalo. *Rev. Ind. Agríc. Tucumán*, 1978, **55**, (2), 1-14 *(Spanish)*. – Cane flowers sporadically under natural conditions in Tucumán, but the pollen is sterile because of the low night temperatures. In order to obtain flowering for breeding purposes, experiments were conducted on photoperiod and temperature adjustment, as well as removal of leaves and adjustment of day-length after floral induction to stimulate or delay flowering. The results showed that removal of leaves +3, +4 and +5 had little or no effect, while leaves +1 and +2 are highly receptive as far as the flowering stimulus is concerned.

A minimum height was found necessary for stimulus perception by the plant but differed with variety. Results of synchronization experiments were erratic but some varieties responded positively.

Trends in the fluctuations in area and productivity of sugar cane in different states of India. P. S. Gill. *Maharashtra Sugar*, 1979, **4**, (6), 37-47. – The trends in cane area and yield per ha in the fourteen cane-growing states are discussed.

Inorganic constituents of sugar cane juice as influenced by irrigation and fertilizer application. T. R. Srinivasan and Y. B. Morachan. *Indian Sugar*, 1979, **28**, 433-439. The effects of planting date, irrigation, fertilization and ripener application in various quantities and at varying times on total N, P and K in Co 419 cane were studied. The results are given in the form of tables, demonstrating marked interactions between certain factors, but showing that all had a greater or lesser effect on the three constituents.

Studies on sugar cane ratoons. V. S. Mane and C. S. Salunkhe. *Indian Sugar*, 1979, **28**, 441-444. – Experiments are reported in which nitrogen was applied at three dosage rates to plant cane and 1st and 2nd ratoons of Co 740 cane. Apart from the expected increase in yield with increased N application, there was a marked increase in yield of ratoons by comparison with plant cane, 2nd ratoon yield being 100.67 tonnes.ha^{-1} compared with 94.02 tonnes.ha^{-1} for 1st ratoons and 89.90 tonnes.ha^{-1} for plant cane.

Assessment of rates and time of nitrogen application to the commercial early and late maturing varieties of sugar cane. V. D. Dagade, J. D. Patil and C. D. Salunkhe. *Maharashtra Sugar*, 1979, **4**, (7), 11-15. – Nitrogen was applied at different dosage rates and times to each of two early and two late-maturing cane varieties. Of eight different treatments, the best in terms of plant and sugar yield per ha was application of 150 kg N per ha 90 days after planting followed by a further 150 kg.ha^{-1} 45 days later. Best performance was given by the early variety, Co 1035. Treatment did not affect % germination or tillering ratio.

Graded furrow system of irrigation increases Adsali sugar cane yield. J. D. Chougule and B. R. Patil. *Maharashtra Sugar*, 1979, **4**, (7), 17-19. – Comparison of furrow irrigation at a gradient of 4% with local ungraded furrow irrigation showed that the former method was better in terms of yield, which was increased in both cases by not earthing-up. Water distribution in the graded furrows was better than in the others.

Inter-cultivation increases the yield of sugar cane ratoons in deep black soils. J. D. Chougule and B. R. Patil. *Maharashtra Sugar*, 1979, **4**, (7), 21-22. – Two-year investigations showed that inter-row cultivation, whereby the sides of the ridges were broken, fertilizer applied and the furrows opened, increased the height, girth and number of internodes in the cane and the yield of millable canes by comparison with absence of cultivation (only fertilization being carried out).

Response of sugar cane to nitrogen and phosphate in calcareous soils. K. Thakur, P. K. Bose, B. P. Sahi and R. P. R. Sharma. *Maharashtra Sugar*, 1979, **4**, (7), 23-27. Nitrogen was applied at three dosage rates and phosphate at four dosage rates to cane growing in normal calcareous soil as well as in saline-alkali soil of North Bihar; the former soil had a moderate N content but a low available phosphate content, while the latter soil was low in both N and available P. Both soils had a high phosphate-fixing capacity. Cane response to N was significant up to 200 kg.ha^{-1} in both soils, while phosphate had a positive effect up to 100 kg.ha^{-1} in normal calcareous soil and only up to 50 kg.ha^{-1} in the other soil. Both nutrients had a greater effect on yield in the normal calcareous soil than in the saline-alkali soil. N without P application had a reduced effect, while P application in the absence of N had a very poor and uneconomical effect. A basic application of at least 50 kg P_2O_5 per ha appeared to be essential for higher N efficiency in both soil types.

Effects of intercrops and nitrogen levels on cane growth and its attributes. K. Venktaraman, M. R. Iruthayaraj and Y. B. Morachan. *Indian Sugar*, 1978, **28**, 545-550. The effect of intercropping on cane growth was studied. Intercrops appeared to suppress tillering despite a distance of 140 cm between the intercrop and cane row. Double intercrops had a greater adverse effect on tillering and plant height than did single intercrops, while black gram as intercrop reduced cane girth but caused elongation. Intercropping negatively affected the number of millable canes at harvest but did not influence the weight of individual canes. Addition of 340 kg.ha^{-1} N gave maximum values of all cane growth parameters. All the trials were based on paired rows of cane 60 cm apart.

Critical level assessment and physiological roles of trace elements in sugar cane. A review. I. S. C. Sharma and G. S. C. Rao. *Indian Sugar*, 1978, **28**, 551-556. II. G. S. C. Rao and S. C. Sharma. *ibid.*, 615-620.

I. The literature on assessment of critical levels of trace elements in sugar cane by tissue analysis is reviewed, with emphasis on trace element absorption and translocation, the effect of cane age and variety on the levels, and the significance of tissue sensitivity for accurate assessment.

II. The literature on boron, copper, iron, zinc, manganese, molybdenum and zinc in cane and their association with different enzyme systems and metabolic pathways is reviewed.

Increase, development and variation of the refractometric index (Brix) in six important cane varieties. G. Lerch, R. Reyes, R. García and P. P. Leal. *Cienc. Agric.* (Acad. Cienc. Cuba), 1977, (1), 79-105 *(Spanish)*. – Growth of six cane varieties and variation in juice refractometric Brix were determined at monthly intervals between 2 and 20 months. During this period, stalk height and fresh weight increased continuously, without notable differences between varieties. However, leaf size and total leaf area varied considerably without any correlation with climatic factors. Brix values increased generally from the apex to the base of the stalk, the uniformly high values for B 42231, Ja 60-5 and C 8571 varieties exceeding considerably those of My 5514 and PR 980, that of B 4362 being intermediate. For all varieties except C 8571 a highly significant linear negative correlation was established between Brix of the upper third of the stalk with the logarithm of the total rainfall recorded during the 30 days before sampling. Industrial characteristics at harvest corresponded well with Brix measured at 10 months of age.

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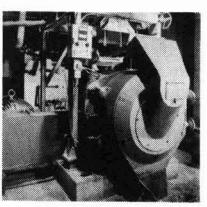

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CANE SUGAR MANUFACTURE

Planning and control of sugar production. A. C. Chatterjee. *Maharashtra Sugar*, 1979, **4**, (5), 21-28. — The author indicates aspects of cane sugar factory operation, attention to which will permit maximization of sugar recovery and minimization of heat losses, water consumption and waste materials.

What to do when an automatic voltage regulator fails. R. Nandagopal. *Maharashtra Sugar*, 1979, **4**, (5), 29-30. When the automatic voltage regulator on a turbo-set at a factory owned by the author's company failed, the turbo-set was kept running by use of a welding generator set, so that cane processing was maintained for many weeks until the regulator had been repaired. Details are given of the various steps in the emergency procedure used.

Increasing the capacity of vacuum pans. A. P. Chinnaswamy and R. Nandagopal. *Maharashtra Sugar*, 1979, **4**, (5), 39-40. — Means by which optimum performance of a low-head vacuum pan is obtainable are enumerated. Of two possible ways in which its throughput can be raised without increasing steam or vapour pressure, installation of a massecuite stirrer is discounted as being too expensive (both as regards installation costs and power requirement); the other is reduction in the dropping and restarting time by a method which has been adopted at one factory. A pipeline with steam valve was installed between the main steam line and the vacuum breaker; when the massecuite is ready for dropping, the steam feed to the calandria is cut, as is injection water feed to the condenser, and the steam valve in the line to the pan is opened instead of the vacuum breaker. When the vacuum has fallen to the desired level, the massecuite valve is opened until steam starts to appear, whereupon the valve is closed and injection water feed resumed to the condenser. The pan is now ready with full vacuum for the next strike. The total time taken is reduced from 25 to 10 min, representing, for four pans operating 20 strikes per day, a 25% increase in working capacity.

Use of material and energy balance calculations in the analysis of sugar factories. C. Manchado, L. Hernández C., R. Fernández T. and H. Pérez de A. *CubaAzúcar*, 1979, (Jan./March), 3-8 *(Spanish)*. — By means of a mathematical model derived on the basis of a flow diagram and experience, different arrangements for an evaporation station are compared in respect of addition water, steam consumption in the pans, surplus bagasse, etc.

Analysis of juice flow factors as an object of control in a sugar factory. M. Silva G., E. Martínez Ch. and L. A. Chirokov. *CubaAzúcar*, 1979, (Jan./March), 12-24 *(Spanish)*. — A statistical analysis is made of the disturbances affecting the flow of juice, the object of control. By application of a parametric scheme to all the subprocesses, each disturbance is characterized by a statistical treatment which permits determination of its magnitude, type of distribution and the corresponding functions of correlation and spectral density. The work provides a premise for identification of the process and implementation of an automated system of regulation of cane and juice flows in a sugar factory.

Comparative study of corrosive aggressiveness between raw sugar and direct sulphitation white sugar manufacturing processes. A. Cepero, F. Corov, R. Hernández and R. Pascual. *CubaAzúcar*, 1979, (Jan./March), 30-37 *(Spanish)*. — Two types of Soviet stainless steel (St-3 and Cr18N10T) were subjected to tests on laboratory and plant scale, the former using model and natural juices in which weight loss and potentiodynamic polarization were measured, and the latter using plates of the steels in the tanks for mixed, clear and sulphited juices, sulphited syrup and in the sulphur burner. Sulphitation conditions produced more corrosion than clarification. St-3 steel was not resistant to sulphitation conditions but might be usable in other parts of the process, while anti-corrosion materials (epoxy paints, polyvinylchloride, etc.) and plastic tubing should be studied and evaluated. The Cr19N10T steel was resistant to corrosion during the work, and its application should be studied as also should other resistant materials.

Considerations on kraft paper multiwall sacks for sugar. J. C. C. Rios. *Brasil Açuc.*, 1979, **94**, 58-61 *(Portuguese)*. The economic and technical advantages of using multiwall paper sacks for sugar, as against cottòn, have been known for many years, but the latter have been retained for socio-economic reasons. The widening difference in cost (CR$ 6 for paper *vs.* Cr$ 18 for cotton) is thought to reinforce the need for adoption of paper for the future.

The Hawaiian sugar industry. A major shift toward energy development is under way. R. J. Leffingwell. *Sugar y Azúcar*, 1979, **74**, (3), 25-33. — Bagasse and cane trash burning to provide power for use in the sugar factory and for electricity supply to the grid is discussed, and mention is made of specific pieces of equipment installed in Hawaiian sugar factories as part of a general program to increase power generation from biomass. The emphasis on energy production has caused changes in the approach to cane breeding which will no longer be aimed at increasing sugar content but at the energy production potential. Research on fuel alcohol production from cane is also discussed. Reference is made to the possible burning of wood chips and other material in factory boilers outside the cane crushing season.

Use of continuous centrifugal machines in sugar factories. A. C. Chatterjee, B. S. Dhavalikar, A. R. Bhide and C. G. Shegaonkar. *Maharashtra Sugar*, 1979, **4**, (6), 25-33. The design, operation, limitations and typical performance of the Walkonti 8 continuous centrifugal are described.

Reduced mill extraction — a new concept. P. K. More. *Maharashtra Sugar*, 1979, **4**, (7), 29-34. — The author examines various formulae for calculation of cane mill performance and attempts to define reduced mill extraction on the basis of solids retained % fibre in bagasse. Comparison is made between reduced mill extraction values calculated by the various methods for 4, 5 and 6 mills in a tandem.

BEET SUGAR MANUFACTURE

A synopsis of the Moorhead deionization plant operating and economic characteristics. S. E. Bichsel, H. A. Davis and A. Sandre. *Sucr. Belge*, 1979, **98**, 67-75. — Details are given of the cation-anion exchange plant at Moorhead which is used to treat a mixture of green syrup and thin juice as well as molasses. Data indicate a non-sugar removal of 73.8% and a colour reduction of 90.2% for the green syrup-thin juice mixture, and a non-sugar removal of 72.9% and colour reduction of 93.7% for molasses. The economics of the plant are discussed. (See also Bichsel & Hoover: *I.S.J.*, 1970, **72**, 246.)

Processing of low-quality beet at Livny sugar factory. Z. D. Zhuravleva, T. A. Lobanova, L. D. Ryazanova and E. F. Telyakov. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (7), 12-23 *(Russian)*. — Details are given of the purification system used for treatment of juice which maintains a high 1st and 2nd carbonatation juice alkalinity without the need to use sodium triphosphate or soda ash, and results are given for 1974 and 1975. The alkalinity levels are 2.2-3.0% CaO (to methyl orange end-point) or 1.2-2.0% CaO (to phenolphthalein end-point) for limed juice, 0.11-0.13% CaO for 1st carbonatation juice and 0.035-0.045% CaO for 2nd carbonatation juice. Thin juice should have a pH of $\leq$ 9.0, and thick juice 8.2-8.5. The economic advantages of the scheme are indicated.

Ebulliometry of industrial solutions of sucrose. V. I. Tuzhilkin and A. A. Slavyanskii. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (7), 24-26 *(Russian)*. Determination of the BPE of industrial sugar solutions is difficult because of overheating, which can be greater than for pure solutions, and because of foaming. Values of BPE are lower for cane sugar factory or refinery products than for beet sugar factory products because, it is suggested, of the lower molecular weight of the latter's non-sugars, many of them inorganic compounds. Considerable differences were found in BPE between factories for the same Brix, purity and pressure, a factor which should be allowed for in development of automatic boiling control systems based on BPE. An empirical equation is given for calculation of BPE, and typical corrections to be made for variation in purity and pressure during boiling are indicated.

Movement of colloids throughout the sugar factory. E. B. D'yakova, V. A. Loseva and A. R. Sapronov. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (8), 7-10 *(Russian)*. — Colloids can be divided into two groups: those entering the juice from beet, and those formed during processing. At Volokonovskii factory the level of colloids was determined in September, October and November in juices up to and including thick juice as well as in 1st massecuite run-off and molasses. The determinations were made gravimetrically and by light scattering. Results indicated a gradual fall from pressed juice to carbonatation juice, the thick juice content being slightly higher than in carbonatation juice; the levels in molasses were higher than in pressed juice in the first two months and slightly lower in November. Differences were found between the three months and between the two methods of determination. Beets stored for a prolonged period contained more colloids and peptides, so that more colloids and melanoidins (from the peptides) were generated during processing.

Dependence of lime consumption on raw juice purity and its predefecation coagulate content. V. M. Priimak and I. I. Sil'vanyuk. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (8), 11-16 *(Russian)*. — It is pointed out that lime added to raw juice will remove only some of the molecularly dissolved non-sugars by neutralization, degradation and precipitation; however, complexes formed between calcium and albumins, pectins and colloids form a coagulate with the precipitated non-sugars. This contains about 0.5% organic solids (on beet), for the removal of which 0.4% CaO on beet is theoretically required, or 12.8% on soluble non-sugars. On the other hand, for removal of the 0.5% organic solids by conventional mud filtration the amount of lime required is about 2.5% CaO on beet, giving a required 8-12-fold quantity of calcium carbonate. A nomogram is given for establishment of the lime requirement in preliming and 1st carbonatation as a function of the non-sugar content and coagulate solids. Removal of predefecation mud by centrifuging before further processing of the juice is recommended as one means of improving purification efficiency.

Physico-chemical and microbiological parameters of flume-wash water. N. A. Arkhipovich, V. A. Lagoda and O. P. Nazarova. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (8), 17-21 *(Russian)*. — Investigations of flume-wash water at Salivonkovskii factory in 1975 are reported. The temperature of the water is governed by weather conditions and quantity of condenser water added to it. With a fall in temperature, the amount of suspension removed by settling falls because of increased viscosity and occurrence of convection currents. The strong odour of the water is due to bacterial fermentation processes, which are also largely responsible for the high colour, while the turbidity is due to the presence of insoluble mineral and organic impurities. The pH is usually 6.5-7.5. Of the dissolved substances making up 60-85% of the organic impurities, sucrose constituted 80%, invert sugar 16.5%, and humins and sulphur acids 3.5%. Chloride, sulphate and total N contents were, respectively, 56.1-78.3, 58.4-77.7 and 15.8-19.7 $mg.litre^{-1}$. The bacterial counts rise sharply with increase in sucrose and invert sugar. An indication is given of BOD_5 and COD values.

Development of an optimum processing system for purification of juices from Belorussian beet. M. P. Storcheus and N. A. Arkhipovich. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (11), 9-14 *(Russian)*. Details are given of tests on six systems to establish an optimum scheme for juice from the low-quality beet (of high reducing sugars, ash and N contents) grown in the peaty, boggy soils of Belorussia. The best scheme proved to be that involving recycling of mud suspension from 70% of 1st carbonatation juice to progressive preliming at 60°C to pH 11, followed by fractional cold and hot liming (10 min each at 60°C and 85°C) and normal 1st and 2nd carbonatation. This gave a juice purity 0.4-1.4 units higher than in the control.

LABORATORY STUDIES

Application of the Remat 10 process control refractometer in the column chromatographic analysis of saccharides. K. H. Rademacher and W. Nebe. *Jena Rev.*, 1978, **23**, (6), 282. – A Remat refractometer made by VEB Carl Zeiss Jena, with a 50 µlitre F51 Fresnel cell between the flow-through and reference compartments in place of the normal 1.9 cm^3 cell, proved suitable for determination of mannose, sucrose and raffinose in 30, 60 and 100 mg mixtures (made up of equal proportions of the three sugars) after column chromatographic separation. The 0-2 mV range of the MKE/T1 recorder was used so as to increase sensitivity, but (as demonstrated by an elution chart) a minimum of 10 mg of each component was needed for a distinct needle deflection.

Correlation between beet sugar content and cell juice density as sugar beet quality indicator. H. Zaorska, S. Zagrodzki and W. Wewiórski. *Gaz. Cukr.*, 1979, **87**, 73-78 *(Polish)*. – Laboratory investigations revealed a close correlation between beet brei pol and refractometric Brix (coefficient of 0.80 for low-purity juice and 0.82 for high-purity juice). Statistical evaluation showed that the mean difference between the true pol:Brix ratio and the calculated ratio was smaller than the mean difference between the pol and the actual sugar content. It is therefore recommended to use refractometric Brix measurements as a guide to beet quality, since the method is more rapid and less involved than polarization, while polarimetric measurements can be made at less frequent intervals as a check.

Study of the acid behaviour of sucrose in the presence of alkaline bases. C. Francotte, J. Vandegans and D. Jacqmain. *Sucr. Belge*, 1979, **98**, 61-66 *(French)*. Potentiometric titration of sucrose (0.18M and 0.36M) with 2N NaOH, using a glass electrode for pH measurement, indicated an acid-base reaction between the sucrose and NaOH. Coulometric titration of a 10^{-2}M sucrose solution, using a hydrogen electrode, gave three values of pK (calculated by computer): 12.02, 12.56 and 12.01. However, it is suggested that the NaOH-sucrose reaction is one of ion exchange rather than an acid-base reaction; reasons for this view are stated.

The identification of volatile constituents in sugar cane and cane sugar products. M. A. Godshall, M. G. Legendre and E. J. Roberts. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 46-47. – A novel method of direct elution of volatile compounds for analysis by gas chromatography and mass spectrometry has been utilized to identify major and minor aroma constituents in cane sugar products. In one sample of cane molasses, 23 compounds were identified. Volatiles in fresh cane leaves, frozen cane juice and raw sugars were also examined. It is possible to use the method to detect differences in raw sugars and to determine if volatiles are formed during processing or are present unchanged from the cane plant.

Some observations on the high molecular weight colorants in sugar. E. J. Roberts and M. A. Godshall. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 68-80. – High-molecular colorants in the same raw sugar, washed and unwashed, were fractionated by dialysis in bags with M.W. cut-off values of 3500, 8000 and 12,000. The fractions and the non-dialysable colorants were compared for the two sugars. Washing removed much of the original colour but the proportions of the washed sugar colour retained by the bags were greater than the corresponding proportions for the unwashed sugar, except in one case. Mild hydrolysis of the non-dialysable material (refluxing 1 hr with N H_2SO_4) yielded a number of polyphenolic acids.

Technique for the isolation of cane sugar colorants. D. Linecar, N. H. Paton and P. Smith. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 81-91. – Colour in mill syrup was concentrated by passage through and adsorption on Rohm & Haas XAD-2 resin, washing free of sugar and elution with methanol. The colorants were then fractionated by large-scale dextran gel permeation. More than 20 phenolic derivatives and 50 flavonoids were detected in the fractions, and isolation and purification of one of the latter, tricin-7-diglucoside, is described.

Sugars in molasses. M. A. Clarke and M. A. Brannan. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 136-148. – A high-pressure liquid chromatographic method developed for sucrose, dextrose and levulose has been applied to a variety of molasses samples, and techniques for applying HPLC analysis to molasses are discussed. The results are compared with those obtained by classical analytical methods and the deficiencies in copper reduction and double-polarization methods demonstrated. The observation that the dextrose:levulose ratio is frequently less than 1 is discussed; the levulose is consumed or reacts quicker than dextrose in purer solutions, while in low-purity liquors the reverse is true.

Sucrose loss through decomposition in refinery liquors. M. A. Clarke and M. A. Brannan. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 149-157. – High-pressure liquid chromatographic analysis has been used to follow sucrose levels and the manufacture and destruction of invert sugar throughout the refining process. Analyses are presented for raw sugar, washed sugar, melt liquor, liquors off char, and first syrup; further analyses are to be made in a continuing program.

Improved 100°S point and pol. A. L. Cummings, B. Coxon, H. P. Layer and R. J. Hocken. *Proc. Tech. Session Cane Sugar Refining Res.*, 1978, 191-205. A newly constructed polarimeter and highly purified sucrose were used to re-determine the 100° point of the saccharimeter scale at 546 nm. The result differs from previously reported results by 140-500 ppm. In addition to the low-pressure mercury discharge lamp, He-Ne lasers at 546 nm and 633 nm wavelengths have been employed to advantage as polarimeter light sources and improve the sensitivity, accuracy and reproducibility of measurements while decreasing the measurement time. These and related investigations point the way to future improvements in determination of the pol of technical sugars.

Laboratory studies

Application of high-pressure liquid chromatography for analysis of certain sugar products. S. Rydel. *Gaz. Cukr.*, 1979, **87**, 79-81 *(Polish)*. – A description is given of a HPLC procedure for sugars separation and determination in standard solutions, thick juice and cane molasses. A 250 x 4.62 mm steel column containing Spherisorb S5-NH of 5 μm particle size was used, with 80:20 acetonitrile:0.01M acetic acid as mobile phase; flow rate was 1.9 $cm^3.min^{-1}$. A spectrophotometric and refractometric detector were used, signals being transmitted to an integrating counter with print-out facilities. Tabulated values are given of the individual sugars for each sample.

Quantitative determination of metallic elements. E. Waleriańczyk and H. Gruszecka. *Gaz. Cukr.*, 1979, **86**, 82-83 *(Polish)*. – Atomic absorption spectrophotometry was used to determine metals in beet thick juice, massecuite, sugar and molasses, and the ranges of values found are tabulated for Fe, Na, K, Ca and Mg. By far the most dominant element was K; Na was the next highest in quantity, but constituted in most cases only some 35% of the amount of K found, while Ca followed Na. Fe and Mg were present in only small quantities.

Non-corrosive dye reagent for detection of reducing sugars in borate-complex ion-exchange chromatography. M. Sinner and J. Puls. *J. Chromatogr.*, 1978, **156**, (1), 197-204; through *Anal. Abs.*, 1979, **36**, Abs.4C17. Sugars separated by ion exchange of their borate complexes[1], with ethanol as eluant, are detected by reaction with the Cu(I) complex of 2,2'-bicinchoninate[2]. Reaction times of <1 min are achieved with a reaction coil of 0.3 mm i.d. at 120°C, which is faster than with 0.7-mm coils at 100°C; 0.1-30 μg of 50 common sugars can be determined with a C.V. of $<1\%$ (9 results for each sample).

Evaluation of the decolorizing capacity of active carbon. R. Bretschneider, J. Čopíková and Z. Cibochová. *Listy Cukr.*, 1979, **95**, 88-93 *(Czech)*. – Comparative tests were conducted with seven active carbon samples (of which one was a standard Carboraffin from the Central Research Laboratory) used to decolorize dilute beet molasses at four factories as well as a standard molasses, raw sugar and chocolate colorant solutions. Performance was judged on the basis of the difference between initial and final absorbance. Results obtained under identical static conditions indicated wide differences in carbon performance at each factory and between the factories, and it is concluded, from statistical analysis, that values obtained with use of a standard carbon and a standard molasses are not valid as a basis for comparison.

Relationship between colouring matter formation and aldehydes in alkaline hexose degradation. H. Andres, I. Arisan and V. Prey. *Zuckerind.*, 1979, **104**, 278-282 *(German)*. – Details are given of gas-liquid chromatographic studies of glycolaldehyde and glyceraldehyde formation as a result of degradation of 0.1M dextrose solution in the presence of 0.1N NaOH at 30° and 80°C, NaOH and H_2O_2 (3.6 cm^3/250 cm^3 reaction solution) at 80°C, and milk-of-lime (containing 88 mg CaO per cm^3) at 30°C. The sugar and alkali solutions were mixed in 1:2 ratio. Colour formation parallel with aldehyde formation was observed by measuring extinction at 420 and 560 nm and absorption in U.V. light in the range 200-390 nm. Plots on a time scale are reproduced. Whereas glycolaldehyde was formed from the very start of the reaction, glyceraldehyde formation took place only after 15 min at 80°C, and only after 20 hr did the proportion of glyceraldehyde increase at the cost of glycolaldehyde. The maximum aldehyde concentration in the presence of NaOH was 10-20 times greater at 80° than at 30°C; the pattern of aldehyde behaviour and extinction at the lower temperature was similar to that in the presence of milk-of-lime at 30°C. The presence of hydrogen peroxide with NaOH caused the aldehyde concentration to reach a practically constant value after 10 min and prevented colour formation.

Colorant distribution in white sugar crystals of high colour. M. Saber Guda, I. F. Bugaenko and A. R. Sapronov. *Sakhar. Prom.*, 1979, (5), 43-46 *(Russian)*. White sugar samples were mixed with a saturated sucrose solution and thoroughly agitated for 20 min (to simulate affination) after which the crystals were separated by vacuum filtration; colour reduction was approx. 20%. Fractional dissolution of 20-g samples of affined beet and cane sugar in 75% aqueous alcohol was carried out under vacuum, and the amount of sugar dissolved was determined by weighing before and after each stage. Each fraction was then subjected to spectral analysis, which showed that the curves for beet and cane sugar were identical, with maxima at 265 and 295 nm, corresponding to reducing sugar alkaline degradation products and melanoidins, respectively. By dissolving crystal sugar containing 0.0095% and 0.0090% colouring matter (beet and cane sugar, respectively) in alcohol, it was found that most of the colouring matter removed was in the surface film surrounding the crystals; from the difference in colorant composition between unaffined and affined sugar and from the colorant distribution within the crystals, it was concluded that the residual colouring matter (70-80% of the original) was in the form of inclusions. Hence, for highly coloured sugars, affination is considered inadequate, and adsorption methods should be adopted.

A rapid method for determining the reducing matter content in products of sugar manufacture. A. Ya. Zagorul'ko, E. K. Ivanishenko and L. A. Korobeinikova. *Sakhar. Prom.*, 1979, (5), 49-53 *(Russian)*. – In the method described, the sample (2g molasses, 10g thick juice, 50g 2nd carbonatation juice, 5g massecuite, 5g run-off, 20g sugar or 52g beet brei – the last two suitably pre-treated) is treated with 9 cm^3 of a 5:4 mixture of basic lead acetate and neutral lead acetate in a 100 cm^3 flask and made up to the mark with distilled water. After decolorizing with 3g pre-washed Carboraffin, the solution is filtered, and to each of two 2 cm^3 aliquots of the filtrate is added 2 cm^3 of a 1% solution of 3,5-dinitrosalicylic acid. A blank control comprising 2 cm^3 distilled water and 2 cm^3 reagent is also prepared. All three solutions in sealed test tubes are placed in a boiling water bath for 5 min, then rapidly cooled to 20°C. After dilution with 20 cm^3 water, their optical density is measured photocolorimetrically at 490 nm and the value converted to % reducing matter using a calibration curve and formula. Maximum error of determination is ± 0.05% on molasses and ± 0.033% on thick juice. Time taken was 21.5 min (27 min for beet brei), which was substantially quicker than standard methods used.

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[1] Sinner *et al.*: *Anal. Abs.*, 1977, **32**, Abs. 3C53.
[2] Mopper & Gindler: *ibid.*, 1974, **27**, 265.

BY-PRODUCTS

Cane molasses fermentation alcohol industry in Fiji. R. Karan. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 12 pp. – The sugar industry of Fiji is briefly described and energy use in the country outlined. Studies of molasses fermentation to alcohol for blending with gasoline have shown that the process is at present economically unjustifiable, although the project could save foreign currency and provide employment opportunities. However, a distillery being installed by the Fiji Sugar Corporation for production of potable and a small quantity of absolute alcohol will, it is expected, provide experience of value for future power alcohol manufacture. Constraints on a major molasses fermentation industry are listed.

Potential for fermentation alcohol production in Belize. A. L. Ayuso. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 4 pp. – The sugar industry of Belize (involving two sugar factories) is briefly described. Since it is considered unlikely that there would be any chance of increased sugar export quotas in the foreseeable future, the possibility of avoiding overproduction of sugar by manufacturing fermentation alcohol is regarded with interest, provided the economics justified such a venture. However, feasibility studies have yet to be carried out.

Aspects of fermentation alcohol production. T. Saito. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 10 pp. – Experience of Kyowa Hakko Kogyo Co. Ltd. in Japan in production of potable alcohol by fermentation of various feedstocks, including molasses, is outlined, and the advantages and disadvantages of cane juice, molasses, corn and tapioca as feedstock are considered. In examination of the energy requirement for production of ethanol, the most economical process is found to be cane juice fermentation, since all of the energy can be provided by bagasse combustion; moreover, the cane area required for production of a given quantity of alcohol (based on FAO figures) is smaller than that of corn and tapioca. Factors affecting the manufacturing costs of anhydrous alcohol are briefly considered. Treatment of vinasse (of high BOD) is discussed, and a process for manufacture of an organic compound fertilizer is briefly described. Advice is on offer to developing countries interested in alcohol manufacture.

Energy balance for the production of ethyl and methyl alcohol. J. R. Moreira, V. R. Vanin, J. Goldemberg and G. E. Serra. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 36 pp. – Reference is made to the Brazilian National Alcohol Program, under which ethanol is produced from cane juice and blended with gasoline. The future of the Program is under review, and various suggestions are put forward as to how it can be further adapted to meet automotive energy requirements, including blending alcohol with diesel oil to obtain a real reduction in the physical quantity of imported oil. While Brazil has considerable experience in the manufacture and utilization of ethanol, methanol is more competitive with diesel oil than is ethanol. The energy costs of ethanol and methanol manufacture (the former from sugar cane, sorghum and cassava, and the latter from wood) are compared; while 1 kcal of methanol can be produced with less energy input than can 1 kcal of ethanol, it is stressed that many more calculations are necessary for knowledge of the total industrial energy for different crops and processes, and even in the case of ethanol production from cane juice and methanol manufacture by pyrolysis, more precise determination of the energy balance is desirable.

Production, application and marketing of concentrated molasses fermentation effluent (vinasses). W. Lewicki. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 7 pp. – Descriptions are given of three types of vinasse produced in European distilleries and their chemical analyses tabulated. Low-protein vinasse is mainly based on cane molasses or a mixture of cane and beet molasses (with a preponderance of the former), middle-protein vinasse is mainly untreated beet molasses vinasse (sometimes mixed with up to 30% cane vinasse), while high-protein vinasse (mainly from beet molasses) has had some K removed and has been supplemented with inorganic ammonium protein. Use of the vinasses as fertilizer or fodder is mentioned.

The development of Alcogas research in the Philippines. E. M. Sunico. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 22 pp. – Alcogas, a 15:85 alcohol:gasoline blend in which the alcohol was in hydrous form (Hydrous Alcogas) or anhydrous form (Alcogas 99), was tested for various parameters on a number of vehicles. Miscibility studies showed that a homogeneous blend was readily obtainable provided the alcohol was practically dry. In Alcogas 99, 0.9% moisture induced cloudiness and subsequent phase separation, whereas as little as 0.1% caused cloudiness in Hydrous Alcogas, which underwent an irreversible phase separation at 60°F and below, while Alcogas 99 remained clear and homogeneous at temperatures substantially below 60°F. Hydrous Alcogas caused corrosion of ferro-magnetic materials, zinc and zinc alloys and caused stalling of engines in 18% of the vehicles as a result of clogging by corrosion debris; Alcogas 99 did not cause any significant corrosion. Hydrous Alcogas also caused engine problems in half of the vehicles tested, whereas Alcogas 99 caused no problems. Since there would be insufficient molasses to provide a 15:85 blend, it would be necessary to produce alcohol from cane, for which more land would be required. However, at present alcohol blends are more expensive than gasoline per litre, although a program based on Alcogas would have a number of socio-economic advantages, which are briefly discussed.

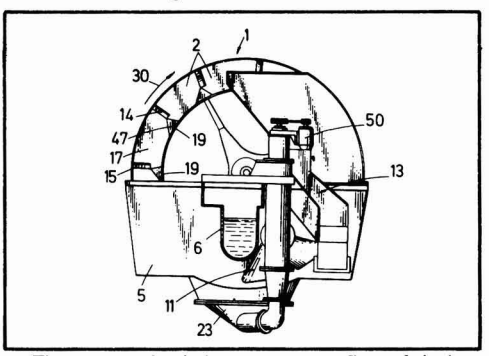
Necessary conditions to promote and realize a policy for energy and chemicals based on "green petrol". P. Mariotte. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 46 pp. – Alcohol production from various forms of plant life for use as motor fuel or chemical feedstock is discussed. Of the various raw materials, sugar cane is considered the most suitable for reasons which are stated. The quantity of molasses produced in the world is thought to be inadequate for any program based on alcohol, but cane juice fermentation would answer the problem. (Mention is also made of alcohol distillation from beet in France.) Politico-socio-economic aspects of alcohol production in developing countries are examined.

PATENTS

UNITED KINGDOM

Continuous separation of debris from flumed beets. Raffinerie Tirlemontoise S.A., of Brussels, Belgium. **1,484,496.** October 14, 1974; September 1, 1977.

Interposed in flume 6 is a separator for dirt, sand, stones, etc., which includes a housing 5 in which rotates a wheel 1 about a shaft mounted on the housing. At the downstream side of the wheel is a perforated drum rotating with the wheel. Water from the sump 23 of the housing is recirculated by a pump driven by motor 50 and delivered through a duct 11 into the upstream side of the housing 5. The wheel 1 is divided into segments 2 by means of partitions 14, the inner part of each being bent, to form a pocket with axial plate 19 and triangular end-plate 47. The downstream side of each segment and pocket is closed by the annular wall 17 of the wheel to which plates 19 and partitions 14 are attached. The upstream side of each segment is open to receive the flow of water through duct 11.



The water recirculation causes an upflow of the beet in the flume but sand, dirt, stones, etc., sink and are lifted out in the segments, collecting in the pockets at the inner end of partitions 14. As the wheel revolves the debris falls out of these pockets into a chute 13 which leads out of the apparatus.

Continuous centrifugal. Fives-Cail Babcock, of Paris, France. **1,484,744.** June 16, 1975; September 1, 1977. See US Patent 3,989,185[1].

Dextrose isomerization to levulose. Standard Brands Inc., of New York, NY, USA. **1,485,167.** November 18, 1974; September 8, 1977. – A solution containing 5 – 80% (40 – 60%) dextrose (a starch hydrolysate), having a viscosity of 0.5 – 100 cp (2 – 20 cp), of pH 6 – 9 [6.5 – 8 (7 – 8)] and at 20° – 80°C, is continuously introduced into a zone containing particles of dextrose isomerase (derived from *Saccharomyces* sp. ATCC 21175) (of activity ≤ 3 IGIU.cm^{-3} when packed in a bed) [and having a stability value of at least 50 (at least 300) (at least 400) hours] bound to a synthetic anion exchange resin or anion exchange cellulose (DEAE-cellulose), whereby up to 54% of the dextrose is isomerized to levulose, the colour is increased by <2 [<0.05 (<0.03)] units and there is substantially no production of psicose [$<1\%$ ($<0.5\%$) ($<0.1\%$)], the treated solution being withdrawn at the same rate as it is introduced.

Increasing (cane) sucrose content. Monsanto Co., of St. Louis, MO, USA. **1,486,156.** December 18, 1975; September 21, 1977. – The sucrose content of cane is increased by application, 2 – 8 (3 – 7) weeks before harvest, of an effective amount (0.11 – 5.6 kg.ha^{-1}) of a compound of the formula $Cl_nH_mC\text{-}CO\text{-}NH\text{-}CH_2\text{-}PO_3XY$, where X and Y are H or a C_1 – C_4 alkyl group, n is 0, 1, 2 or 3 and m = 3 – n, or an alkali metal, ammonium, C_1 – C_4 alkyl or C_1 – C_4 alkanolamine, aniline or substituted aniline salt of the compound (N-trichloroacetyl aminomethylene phosphonic acid, its monopotassium salt, its monoethanolamine salt, its mono-*m*-carboxyaniline salt, its mono-*m*-trifluoromethyl aniline salt, the mono-aniline salt of N-chloroacetyl aminomethylene phosphonic acid, or N-acetyl aminomethylene phosphonic acid). The chemical is applied as an aqueous solution or suspension (containing 0.1 – 2.0% of a surfactant).

Fertilizers and animal feed from molasses fermentation residues. Unisearch Ltd., of Kensington, NSW, Australia. **1,486,765.** September 19, 1974; September 21, 1977. See US Patent 3,983,255[2].

Sugar juice treatment by ion exchange. Rohm and Haas Co., of Philadelphia, PA, USA. **1,488,248.** October 15, 1974; October 12, 1977. – Cane juice (clarified and brought to 10 – 25°Bx) or beet juice is purified by bringing into contact (at 40° – 65°C) with a weakly basic anion exchanger in the HCO_3^- form and (then) at a pressure above atmospheric (and at 40° – 65°C) with a strong acid cation exchanger in the alkaline earth metal ion (Ca^{++}) form so as to convert Na and/or K salts first to their bicarbonates and then to exchange the cations for Ca, leaving $Ca(HCO_3)_2$ in solution. Finally, the juice is deashed [by liming or by heating (at below atmospheric pressure) to precipitate $CaCO_3$] and the clarified sugar solution separated. The cation exchange resin is regenerated with ammonia and the regenerant waste treated with CaO to re-liberate NH_3. CO_2 from thermal deashing is used to regenerate the anion exchange resin.

Beet harvesters. Wilhelm Stoll Maschinenfabrik GmbH, of Lengede/Broistedt, Germany. **1,488,303.** June 10, 1975; October 12, 1977.

Increasing cane sugar content. May and Baker Ltd., of Dagenham, Essex, England. **1,488,485.** November 20, 1973; October 12, 1977. – The yield of sugar from a cane crop is increased by (foliar) application, after

[1] *I.S.J.*, 1980, **82**, 192.

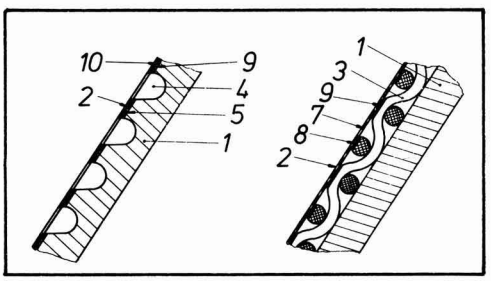
[2] *ibid.*

copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price £1.25 each). United States patent specification are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).

close-in of the canopy [2 – 11 (2 – 6) weeks before harvest], of an effective amount [0.05 – 12 (1 – 7) kg.ha^{-1} acid equivalent] of asulam (methyl N-4-aminobenzene sulphonamyl carbamate) or a (Na or K) salt, which does not harm the normal growth of the cane, and harvesting at the time of maximum sugar content. The application may be as a liquid (aqueous) formulation [containing 0.01 – 95% (0.05 – 50%) of asulam] including a surface-active agent, fertilizer, trace elements or insecticide.

Screen for continuous centrifugal. Braunschweigische Maschinenbauanstalt, of Braunschweig, Germany. **1,489,857.** June 17, 1976; Octoger 26, 1977.

The screen 2 fitted to the conical basket 1 of a continuous centrifugal may be supported by webs 5 between the grooves 4 into which mother-liquor passes in operation, or it may be supported by the supporting



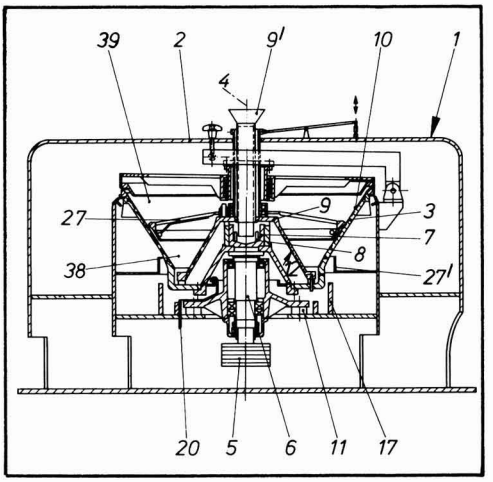
mesh 3. In either case upward and outward movement of the screen relative to the basket is opposed by the presence of roughened areas 8 on the underside 7 of the screen which engage with roughened areas 9 on the support.

Screen for batch centrifugal. Braunschweigische Maschinenbauanstalt, of Braunschweig, Germany. **1,490,175.** June 17, 1976; October 26, 1977. – During the discharging of sugar from a batch centrifugal, the action of the plough, counter to the slow rotation of the basket, causes a shearing action which tends to expand and displace the screen. In order to avoid this the outer side of the screen is provided with roughened areas, e.g. by electroplating, sand-blasting or grinding, or a friction lining interposed between the screen and the supporting backing mesh or webs in the case of a grooved drum. (See also UK Patent 1,489,857 on this page).

Continuous centrifugal. Braunschweigische Maschinenbauanstalt, of Braunschweig, Germany. **1,490,323.** June 4, 1976; November 2, 1977.

Massecuite, particularly of white or second-product sugar, is admitted to the continuous centrifugal 1 through an inlet pipe 9', is distributed uniformly in acceleration bell 9 by means of pins 8 from cup 7 and passes downwardly and outwardly over screen surface 12. Mother liquor passing through this screen collects in a peripheral channel from which vertical drain pipes at intervals around the channel conduct the mother liquor to the bottom of the chamber on the inside of annular wall 17. Wash water is delivered by pipe 20 and passes through channels in the support provided for cup 7 and mingles with the sugar passing over the lower edge of screen 12.

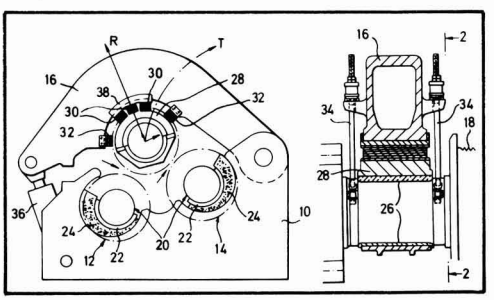
The mixture passes upwardly to the screen surface 3 of the main basket and continues as a thin layer underneath the plate 27 which is adjustable axially to locate as



closely as possible to the sugar layer (but without touching it and causing crystal abrasion) ducts through which steam or water is admitted for final washing of the sugar before it passes upwards and is discharged.

Cane mills. Fives-Cail Babcock, of Paris, France. **1,494,306.** July 23, 1976; December 7, 1977.

The cane mill housing comprises a pair of lower frames 10 supporting a feed roller 12 and a discharge roller 14 with two pivoting heads 16 from which is suspended the top roller 18. The lower rollers are provided with journals 20 mounted in bushings 22 located by chocks 24. These are crescent-shaped and so make possible adjustment of the position of the rollers relative to the frames.



The top roller is provided with journals 26 mounted in bearings 28 which are connected to the respective heads 16 by means of three elastic blocks 30 arranged along a cylindrical surface centred on the axis of roller 18 and symmetrically relative to the plane containing this axis and the resultant R of the forces acting on the roller during normal operation of the mill. The blocks are made of synthetic rubber or similar material with metal plates on their faces or of alternative rubber and metal strips. They are mounted on support 38, the position of which is adjustable. Elastic abutments 32 are also provided on the heads 16 to limit displacement of the roller 18. In operation, the blocks permit movement of the roller relative to the head on occasions when a sudden increase in cane blanket thickness occurs on one side of the mill without the loss of compression which would result on the other side by movement of both heads against the hydraulic jacks 36.

Guyana sugar exports[1]

	1977	1978	1979
		tonnes, raw value	
Algeria	5,673	0	0
Canada	21,271	56,807	79,801
Caribbean Islands	321	958	636
China	856	0	0
Denmark	52	0	0
Germany, West	46	23	0
Holland	314	154	0
Portugal	0	14,505	0
UK	177,543	165,656	159,836
USA	11,528	57,353	39,750
Other countries	5	0	212
	217,609	295,456	280,235

Filtration conference and exhibition. — Papers are being sought for the Filtration Society's next International Conference to be held at the Cunard Hotel, London, in conjunction with the "Filtech 81" exhibition to take place at Olympia, London, during September 15-17, 1981. Information on both is available from Pressaids Ltd., Bridge House, 181 Queen Victoria Street, London EC4, England.

CSR Ltd. 1980 report. — Profits from sugar milling in the year ended March 31, 1980 more than doubled, mainly owing to the strong recovery of world market prices for raw sugar. A five-year agreement to stabilize refined sugar marketing in Australia was concluded with the Commonwealth and Queensland Governments. A new long-term contract, providing for the sale of 1,200,000 tonnes of sugar over the five years 1980/84 was negotiated with refiners in South Korea. Port facilities for export of raw sugar were substantially strengthened. The company's mills crushed 5.58 million tonnes of cane to produce 770,300 tonnes of raw sugar, some 27% of the Australian total. High efficiencies were obtained from mill plant. Capital expenditure amounted to Aust.$10.0 million, the major $127 million program of capacity increases which began in 1975 being now virtually finished. Domestic sales of refined sugar totalled 701,000 tonnes while the New Zealand Sugar Co. Ltd. sold 166,000 tonnes. Capital expenditure in the five Australian refineries was $7.2 million and that in New Zealand was $1.3 million.

Egyptian beet sugar project. — A group of British companies have launched a joint project with the Egyptian Government to transform a large stretch of arid desert into productive farm land. The ambitious £280 million plan centres on 100,000 acres of desert in West Nubariya and will involve the resettlement by the Egyptian Government of more than 8000 families. Half the area will be used for the establishment of estate farms and processing factories operated by commercial interests, with the rest divided into thousands of smallholdings of about six acres. The British companies are British Sugar Corporation Ltd., Booker McConnell Ltd., Tate & Lyle Agri-Business Ltd., Guiness Peat (Overseas) Ltd. and Tarmac Overseas Ltd. Morgan Grenfell and Co. Ltd. have been appointed financial advisers to the group. Focal point of the whole project will be a 30,000-acre sugar beet crop serving a modern sugar factory. Sugar beet trials undertaken by Beet Sugar Developments Ltd, a subsidiary of the British Sugar Corporation, have been going on in the area since 1977 with encouraging results. The task of turning desert into rich farmland will begin by levelling and draining the vast area which will then be flooded to remove salts from the soil. Full commercial cropping should begin in 1984.

Chile sugar industry[2]. — The Linares and Los Angeles beet sugar factories of the state-owned sugar company, IANSA, have been sold to Cía. de Refinería de Azúcar de Viña del Mar S.A., the Chilean sugar refining company. Against the $47 per tonne offered to beet growers by IANSA, the new owners are offering $50 to growers to encourage them to resume beet planting, and it is hoped to produce 100,000 tonnes of sugar annually from the two plants. IANSA will continue to operate its other four sugar factories.

New Cuban sugar factories[3]. — Three new sugar factories are to be built in Cuba with a $20 million credit from the Soviet bloc's International Investment Bank. Most of the country's 150 factories are old but recently a new factory began experimental operations in the western province of Pinar del Río; it has a daily cane crushing capacity of 7000 tonnes. Another is under construction in the central province of Camagüey and two others are planned in the southern province of Cienfuegos and the eastern province of Granma (formerly Oriente).

Poland sugar exports[4]

	1979	1978	1977
		tonnes, raw value	
Algeria	8,234	77,923	58,962
Bahrein	11	55	54
Dubai	217	578	489
Egypt	0	11,909	0
France	13,401	0	0
Germany, West	0	1,505	1,761
Iceland	0	39	0
Indonesia	0	17,786	43,118
Iran	0	0	11,367
Ivory Coast	1,085	0	0
Kuwait	325	1,299	460
Liberia	0	367	16
Libya	57,018	113,776	100,395
Mali	0	2,170	0
Morocco	0	0	5,413
Nigeria	0	217	435
Norway	0	4,558	5,111
Qatar	0	108	108
Saudi Arabia	0	12,504	0
Sierra Leone	0	0	54
Sri Lanka	0	0	12,500
Sweden	0	0	2,681
Syria	0	24,413	22,245
Tunisia	0	11,367	0
UK	23,276	0	0
USSR	0	0	5,641
Other countries	52	1,080	0
	103,619	281,654	270,810

Süddeutsche Zucker-AG 1979/80 results. — The good development of the beet crop during the growing period and the almost perfect weather conditions for the harvest and processing of the beet laid the foundation for a successful campaign. From an unchanged growing area of 103,000 hectares, there was a harvest of 5,359,000 tonnes of beet (5,077,000 tonnes in 1978) with a sugar content of 17.69% (17.43%). The good quality of the beet and the new capital investment which had been carried out made it possible for the beet harvest, increased by almost 6%, to be processed in 87 campaign days (against 88 in 1978/79). In total 827,000 tonnes of sugar was produced (759,000), of which 112,000 (44,000) tonnes were C-sugar. Molasses production was slightly lower at 177,000 tonnes (178,000), while dried pulp production reached 323,000 tonnes against 302,000 tonnes. Zuckerfabrik Franken GmbH, an associate company of Südzucker, processed 1.6 million tonnes in its 78-day campaign at the Ochsenfurt and Zeil sugar factories; in 1978/79, 1.7 million tonnes were processed in 86 days. Sugar content was higher at 17.77% against 16.74%.

New Haiti sugar factory[5]. — The USDA recently reported that plans are continuing for construction of a new sugar factory. This would bring the total number of factories to 4. The most likely location remains in the Plaine de Leogane region. According to official sources 6000 new hectares of cane would eventually be established to support requirements of the new mill and the existing mill of the Haitian-American Sugar Company S.A. Of this total, 1500 hectares are expected to be planted and ready for first harvest in calendar year 1981. Apparently government officials visualize that a cooperative-type organization will manage and operate the new mill. Target date for its opening is December 1981. Sugar production in 1980 continues to be estimated at 70,000 tonnes, raw value, despite a very low extraction rate. Apparently increased availability of cane will offset the lower extraction rate by a margin sufficiently to allow attainment of the original calendar year 1980 raw sugar goals for the country.

Malawi alcohol distillery[6]. — Work is expected to start on an ethanol plant project late next year; it will be funded by the International Finance Corporation with a grant of 6.5 million Kwacha (£3,476,000) and will be able to produce motor fuel alcohol from molasses produced at the Dwangwa Sugar Corporation in Nkhota-Kota District. It is estimated that the first phase of the project will effectively replace about 10% of total imported motor fuel.

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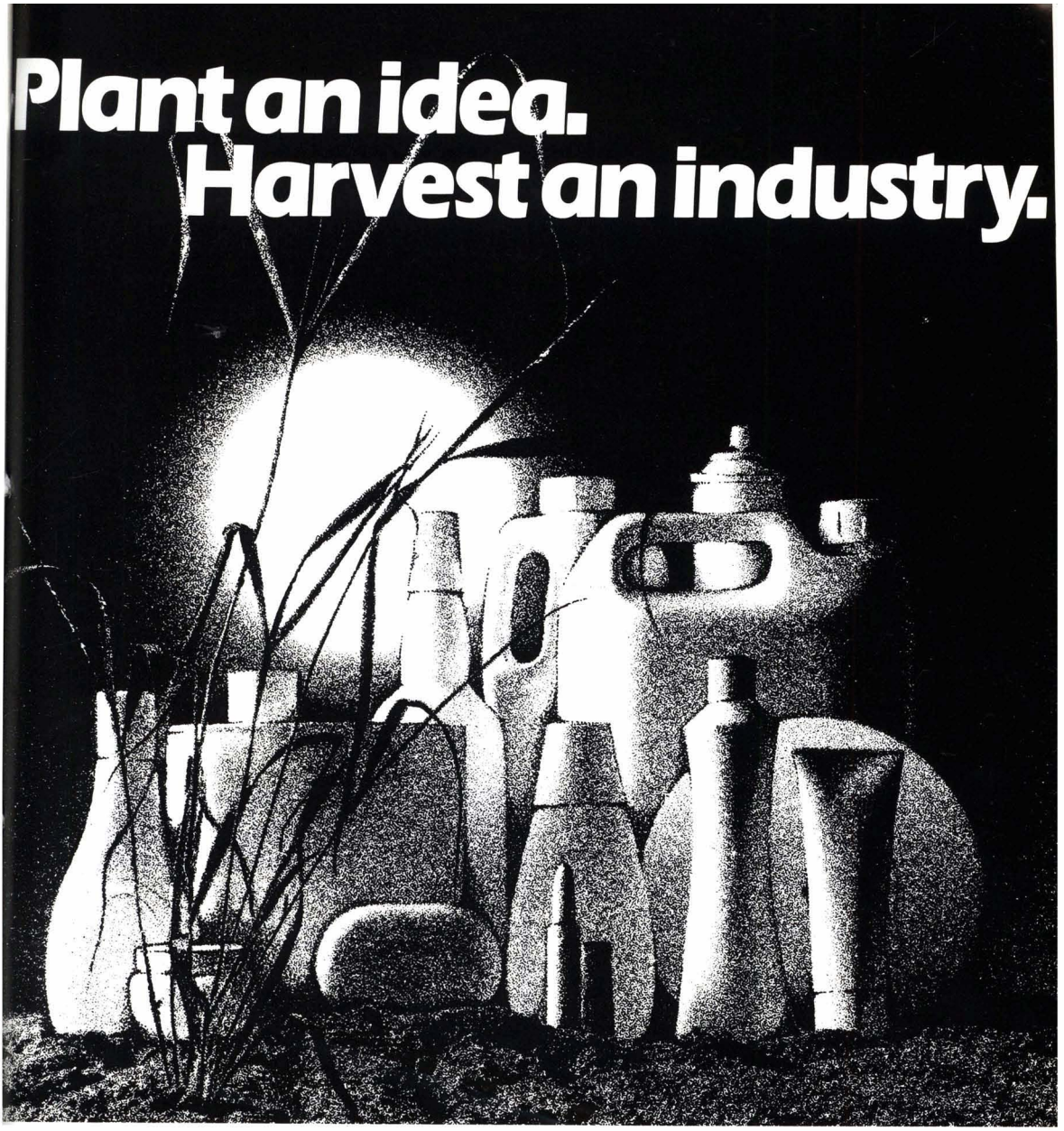
1 *I.S.O. Stat. Bull.*, 1980, **39**, (3), 46.
2 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 297.
3 *Public Ledger*, July 5, 1980.
4 *I.S.O. Stat. Bull.*, 1980, **39**, (3), 73.
5 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 277.
6 *Standard Chartered Review*, June 1980, 6.



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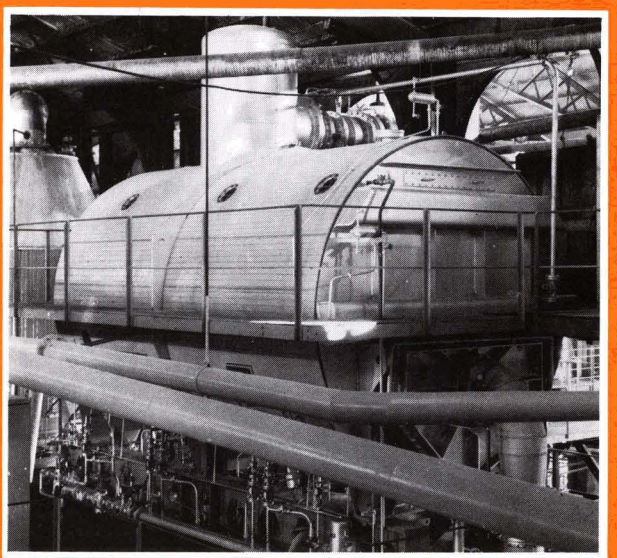

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