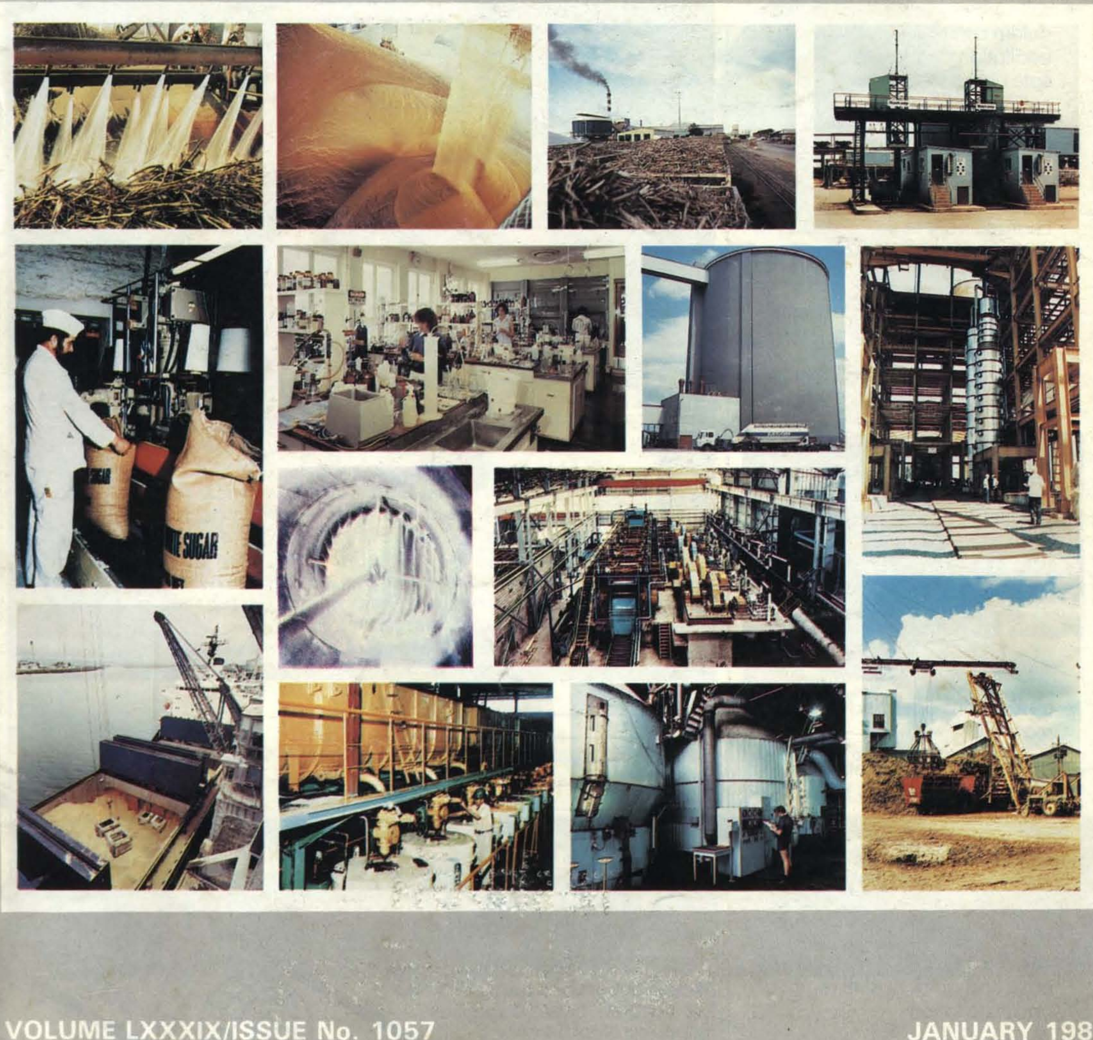
INTERNATIONAL SUGAR JOURNAL



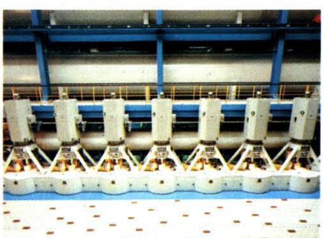
VOLUME LXXXIX/ISSUE No. 1057

JANUARY 1987

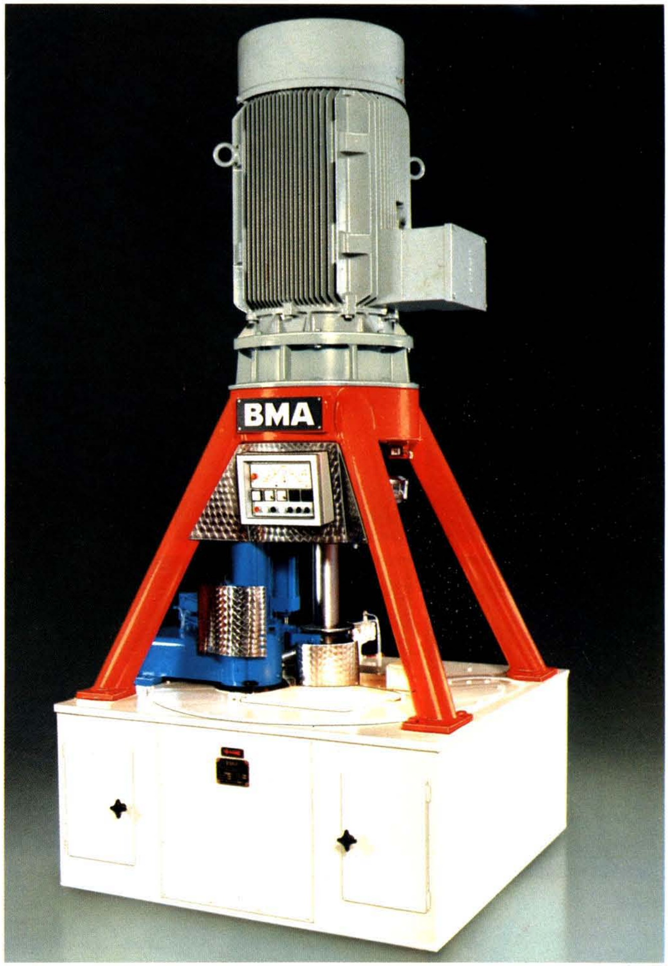
G 1000 and G 1250: Newcomers to BMA's successful line of centrifugals

Upon the insistence of our customers we have now down-sized and supplemented our very successful line of G-series Batch Centrifugals. Formerly, only available in 1500 and 1750 kg sizes (G 1500 and G 1750 models) BMA now also offers this "New Generation" batch centrifugal in two smaller configurations: the G 1000 and G 1250 models, with 1000 kg and 1250 kg charging capacity respectively. These new models offer the same advantages as their bigger counterparts:

- self centering, suspended pendulum centrifugal with adjustable oscillation damper to compensate unbalances through-out the entire speed range
- easily accessible drive head located outside the basket casing
- simultaneous opening of discharge valve and positioning of spindle during the discharging process (patented)
- discharge shoe provided with spring-loaded plow tip
- no sugar incrustation in sugar outlet, eliminating cleaning



- all functions operated pneumatically
- option: all components in contact with the medium can be supplied in S/S
- machines completely assembled, tubed, wired, and test run prior to shipping (no sub-assemblies!)
- options: flanged basket and head spindles are available for easy and quick basket removal and installation
- minimum maintenance and operating costs



Type		G 1000	G 1250
Basket dia., inside	mm	1320	1320
Basket height, inside	mm	1000	1000
Layer thickness	mm	180	230
Charge	kg	1000	1250
Centre distance, staging	mm	1750	1750

BMA

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News and views

World sugar balance, 1986/87

F. O. Licht GmbH recently declared that their first estimate of the world sugar balance for 1986/87 must come as disappointment to all who had hoped for a significant drawdown of stocks this year and significantly higher prices[1]. Current indications, Licht note, are that stocks will fall by not more than 1 million tonnes, against earlier hopes for a reduction of 2.5 million tonnes and predictions by some observers of a fall of 3.5 - 4 million tonnes.

If the estimates materialize, world stocks at the end of August 1987 will reach 35.9 million tonnes, 2.8% less than a year before and the lowest as a proportion of consumption than for a number of years, but still considerably above the traditional level of 25%.

The two critical factors of the balance are the estimates for trade and consumption. The former is forecast to fall nearly nearly 9% as a result of higher sweetener supplies in Asia and North and Central America. Consumption growth is expected to slow down to 1.1%, owing to expected slower growth in developing countries.

Licht's overall figures are reproduced below:

	1986/87	1985/86
	tonnes, raw value	
Initial stocks	36,888,000	40,094,000
Production	101,211,000	97,712,000
Imports	26,177,000	28,763,000
	164,276,000	166,569,000
Consumption	101,575,000	100,434,000
Exports	26,829,000	29,247,000
Final stocks	35,872,000	36,888,000
" " % consumption	35.32	36.73

International Sugar Council meeting

The autumn meeting of the ISO council took place during November 20 - 21 and it was agreed to extend the present administrative agreement for a further year to the end of 1987. No decision was taken on appointment of a new Executive Director, although the frustration of some members at failure to appoint one of the candidates was expressed by calling for a vote on a requirement for the Council to do so; the vote was defeated, however.

A working group was appointed to examine ways of reducing the costs of administering the agreement and also to establish a fairer basis for apportioning them among members. An assessment of world sugar supply and demand for the 1986/87 season was provided by the Secretariat; this indicated a balance to within 100,000 tonnes, and noted that stocks had fallen by 1 million tonnes from the 1985 level.

Support was given to a proposal for a simplified economic agreement based on market shares in a total market to be forecast at the beginning of each year; obtaining the acceptance by individual countries of their proposed share might be a difficult matter, however, and it is reported that, for instance, Australia has been insisting on a minimum export entitlement which is not acceptable to the EEC.

The recent report by the Food & Drug Adminstration of the US, giving its view after three years of study that sugar was not responsible for any ailments apart from dental caries, was welcomed by the Council and wide dissemination of the findings, in an attempt to counter anti-sugar views and so to increase demand, is to be encouraged.

This same report had been welcomed by a meeting of the executive of the World Association of Beet and Cane Growers which took place in London during November 17 - 18. The meeting was to examine problems facing the world sugar industry and to make further arrangements for the 3rd World Sugar Farmers Congress in July. The association is to lobby consumer groups to dispel false notions about sugar and to try to curb the advance of substitute sweeteners. The establishment of a new International Sugar Agreement was urged, and members of the executive had talks with officials of the ISO; Mr. Fred Soper, Chairman of the Australian Cane Growers Council, did not consider prospects good, however, since, while most people wanted an agreement to make sugar production more profitable, very few seemed willing to restrict output to achieve this end.

World sugar prices

Reports of drought in a number of countries strengthened the world sugar market in the early part of November, as did news of a cane growers' strike in Brazil and reports of negotiations for a large sale of sugar by Thailand to the USSR. These negotiations failed and the sugar was put directly on to the market so that the London Daily Price, which had started the month at $143.50 and had risen to $156 on November 10, fell the next day to $150.50. Subsequently, a variety of contradictory factors influenced the market, including large releases by the EEC, higher estimates of sugar crops in Europe, significant purchases by Venezuela and Indonesia and an ambiguous report of a million-tonne shortfall in the Cuba crop. These, combined with quiet trading, kept the sugar prices relatively stable during the rest of the month so that the LDP fluctuated between $153 and $146.50, ending the month at $148.50, while the LDP(W) which had started the month at $181, had risen to $188 and fallen to $181 again on November 12, fluctuated between $183 and $178.50 per tonne, ending the month at $179.

E. D. & F. Man comment[2]: "There is little reason to be dogmatically bullish or bearish for the coming weeks. It should be noted, however, that the market is in the middle of a period of broad statistical balance after allowing for a limited draw-down of stocks, but nevertheless market prices remain very low. Historically, the next major movement from such a situation is a significant rise in prices, induced by a perceived shortage."

Record Venezuela sugar production[3]

Sugar production in Venezuela from the 1985/86 crop is reported to be between 520,000 and 540,000 tonnes, white value, representing a record for the country.

1 *Int. Sugar Rpt.*, 1986, **118**, 569 - 575.
2 *The Sugar Situation*, 1986, (427).
3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 524.

Storing and loading white sugar in bulk

By Alain Meuret
(Head, Mechanical Engineering Dept., A.B.R. Engineering, a division of ABAY, Brussels, Belgium)

Conditions necessary for the perfect storage of white sugar include hermetic sealing, achievement of air-sugar moisture equilibrium, adequate heat insulation, automatic operation and the ensuring of plant safety in respect of explosion risks. These are discussed below.

Hermetic sealing

It is essential that the entire storage zone be completely sealed and watertight to prevent any kind of pollution from outside agents such as dust, humidity, non-conditioned air, animals, etc.

Air-sugar equilibrium

Two main factors are to taken into consideration: the moisture equilibrium between air and sugar, and maturation phenomena (crystallization after the dryer operation of sugar from the supersaturated film of syrup around the crystal).

The selection of a stable point of equilibrium is fundamental for good sugar preservation. To achieve this equilibrium (0.02% water content in sugar, 35% R.H.), the free water resulting from maturation must be evacuated as and when it appears, and the sugar should be dried slowly to 0.02%.

Heat insulation

Any cold point or temperature gradient is detrimental to the good preservation of sugar. Moreover, when the stored sugar is at the chosen stable point of equilibium, any change in the air temperature must be avoided as it would alter its relative humidity. The sugar must also be kept at constant temperature. For all these reasons, the silo shell must be maintained at a constant temperature about the same as that of the sugar, whatever the atmospheric conditions may be outside.

Automatic operation

Handling operations inside the silo should be made as automatic as possible in order to minimize the risks of pollution of the sugar, personnel costs, and energy consumption, as well as to provide optimum safety of operations.

Safety as regards the risks of explosion

Explosion can occur when sugar dust concentration falls within a certain range. To limit the disastrous effects of the propagation of an initiated explosion, the presence of sugar dust at the upper storage level must be reduced to a minimum. To minimize the risk of explosion, precautions should be taken; for instance, all sources of electrical or mechanical ignition should be eliminated by avoiding as far as possible the presence of electrical equipment and moving parts inside the storage zone.

A. Meuret

Sugar dust formation is almost inevitable, owing to the nature of the product to be stored. However, it is important to reduce the creation of dusts to a minimum and to avoid any segregation of sugar to prevent a concentration of dusts.

The ABR vertical steel sugar silo

The ABR silo has been designed to provide solutions to all the problems involved in storing white sugar in bulk. The silo is completely sealed since the shell, the roofing and the base are all made from welded steel plates.

To reach a stable point of equilibrium the silo must operate like a slow dryer. The removal of excess moisture may not be achieved in a short time, but it is necessary to extract any excess humidity as it appears during the silo filling operations.

This is the important role played by the closed system which continuously blows conditioned air through the sugar mass to remove excess moisture from the sugar.

It is important to note that air conditioning above the sugar mass may not be considered a satisfactory solution because it cannot dry the sugar slowly enough. The sugar to be "post-dried" is in contact with this volume of air far too quickly for it to be dried slowly.

Compensation heating of the shell is needed to maintain the stored sugar at a constant temperature whatever the atmospheric conditions outside. A hot water network at about the same temperature as that of the sugar maintains the shell and the roof at a constant temperature.

Internal handling of sugar within the vertical steel silo involves a beam fitted with two symmetrical arms which rotates around the central column at the top of the silo. From this beam a second distributing beam fitted with rakes is suspended by means of a patented pulley system. The rakes gradually push the sugar from the central column to the silo shell during the filling operation. During the emptying operations, the beam with rakes rotates in the opposite direction, pushing the sugar from the shell towards the central column.The patented pulley suspension system automatically controls the rotation and the upwards and downwards movements of the distributing beam.

This "static" handling system (using rakes) ensures that the silo is filled correctly without having to use any mechanical equipment; it also ensures that the silo can be emptied completely. It is to be noted that all the machinery and electrical devices are housed at the top of and within the central column and are therefore located outside the storage zone.

Protection against the risk of explosion

There are no sources of ignition within the sugar storage zone of a vertical steel silo since there is no electrical equipment, nor any moving mechanical parts likely to produce a spark, in this zone.

The volume of sugar dust is reduced to a strict minimum thanks to the fact that it is removed continuously from the storage zone by the ventilation system, bag filters being included in the conditioned air stream.

Sugar entering the silo is handled inside closed zig-zag chutes in the central column to reduce the formation of dust and the rakes used for filling the silo turn the sugar over, making sure that the grain size distribution remains homogeneous without dust-causing segregation.

Operating costs

The operating cost of an ABR silo is insignificant; no operating staff is required because the silo is completely automatic and empties almost completely. Total annual consumption of energy (fuel oil and electricity) is very low, while maintenance costs are also very low.

The number of ABR silos constructed in a dozen different countries is now 27, representing 864,000 tonnes of sugar storage capacity, and includes installations for Raffinierie Tirlemontoise, Belgium; Südzucker, West Germany, and British Sugar, England.

Loading of white sugar in bulk

World transport of refined white sugar is currently undergoing considerable development. Until recently this type of sugar could only be transported in bags by ships. Owing to the increase in the amount of white sugar entering world trade efforts have been made to find solutions which are better suited to our times.

For this reason the ABAY company have designed a specific plant intended to load a ship directly with bulk white sugar. The advantages of this new technique are obvious; loading time and dead-time while the ship is moored in the dock are reduced (bulk loading at 700 tons per hour instead of 120 to 200 tons per hour in bags), dead time during the voyage may be used to carry out the bagging operations and it is possible to unload the sugar in bags at ports which are not equipped with plants to receive sugar in bulk, etc.

The functions of this sugar loading plant are as follows: It transports the sugar from the weighing station of the terminal to the ship's flange inlet at a rate of 700 tonnes per hour while maintaining during the entire period of transfer appropriate conditions necessary for handling granulated white sugar (preventive measures against pollution, humidity and the risk of explosion).

It guarantees that the ship is loaded completely without having to be moved at all, once it has been moored; this takes account of the natural motion of the ship (sinking by 7½ metres of the ship during loading, listing and displacement of the flange inlet within a horizontal area 4 metres in diameter).

The sugar is transported by means of a belt conveyor from the weighing plant through a tubular mono-shell gallery to the station situated at the top of the loading gantry-crane. Via a special rotating chute, the sugar is discharged onto the conveyor of the rotating jib of the gantry crane from where it is discharged into a telescopic chute which supplies the flange inlet in the ship.

The final design of this telescopic chute is covered by an ABAY patent. It is designed like a double telescopic Cardan with stainless steel tubes and double independent casing to permit the dust removal from the inlet in the ship.

The winch for manoeuvring this chute is equipped with a system which is also patented and which, once placed in automatic change-over, controls the take-up and slack motions of the ropes, depending on the position of the ship.

This plant can thus be used in perfect harmony with vertical ABR silos for a sugar terminal.

Summary

The storage of white sugar in bulk is currently practised extensively throughout the world. The author examines the conditions to be fulfilled to obtain the best possible storage of the product, and gives a description of the ABR-type vertical silo, the design of which statisfies these conditions.

A brief mention is made of dock-side loading of white sugar in bulk, a technique which is today in its infancy but which will no doubt become more widespread within the next few years.

Facts and figures

South African sugar factory fire[1]

During the off-season a fire broke out in one of the bagasse storage sheds of the Transvaal Sugar Corporation Ltd. and spread rapidly along the conveyor system as far as the factory's only bagasse-fired boiler house. The overhead sprinkler system was manually operated and only a skeleton staff was on duty; consequently, when the water was turned on, the pipes were red-hot and burst, so that the fire had to be fought with hoses and extinguishers. Damage was extensive and required replacement of structural steel supporting the gantries, electric-al power and inspection television circuits, the conveyors and belting, fire mains and panels on the gantries. As a result of nine continuous weeks of work, 12 hours a day, the repair project was completed in time for the factory to meet its start-up deadline for the 1986 milling season.

Bagasse paper factory for Pakistan[2]

A privately-financed project, awaiting government approval, calls for building a kraft paper factory with a capacity to produce 15,000 tonnes. Under the name Shah Murad Paper and Board Mills Co., its total cost would be 198,500,000 million rupees ($11,700,000 million), of which 113,000,000 million rupees ($6,700,000 million) is in foreign exchange (in suppliers' credit). The basic raw material will be bagasse, but the necessary imports of wood pulp will make necessary a constant expenditure of 23,000,000 rupees ($1,400,000) in foreign exchange.

Ghana distillery[3]

Ghana Sugar Estates has completed the first phase of its rehabilitation exercise, after lying idle for about three years, and the factory is scheduled to come on stream soon with its first production of alcohol for liquor manufacturers in thecountry. In addition, the government has granted the company $100,000 for importing raw sugar for its alcohol plant. It is expected to produce 10,000 litres of alcohol a day.

Kenya sugar industry problems

Several of the sugar factories in Kenya are operating below capacity because of a shortage of cane, according to the Chief Executive of the Kenya Sugar Authority[4]. He made complaints about the state of the industry's infrastructure, research and management, all stemming from lack of funds. It is reported that Nzoia sugar factory has made trading losses ever since it was commissioned in 1978; it has an installed capacity of 2000 tcd but, owing to various faults, it has not been able to exceed 1600 tonnes. Kenya sugar imports are likely to continue rising unless small cane farmers receive adequate incentives, according to industry sources[5]; growers have sometimes had to wait two or three years to receive payment. Sugar imports in 1986 are expected to reach 50,000 tonnes compared with 40,000 tonnes last year.

1 *S. African Sugar J.*, 1986, **70**, 267.
2 *Amerop-Westway Newsletter*, 1986, (154), 10.
3 *Standard Chartered Review*, September 1986, 43.
4 *Carnikow Sugar Review*, 1986, (1753), 140.
5 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 500.

White sugar silos in concrete construction

Thirty years ago sugar was generally stored in bags, a procedure causing important losses of the product and requiring significant capital expenditure. Since then, silo storage has been adopted in many countries and capacity, for example, in German sugar factories amounts to approximately 90% of the annual domestic sugar consumption of about 2.1 million tonnes. Nevertheless, the proportion of silo storage capacity to consumption in different countries varies widely and only a small part of the world's total consumption of approximately 100 million tonnes is stored in silos. Long-term prospects for world-wide construction of white sugar silo plants may thus be considered favourable.

Development

Experience concerning the storage of white sugar in silo plants can be traced back to the 1930's; however, development was more forceful after World War II because of two techniques with which a large number of constructors had become acquainted, namely the use of slipform (sliding shuttering) for the construction of silo walls, and prestressing for limitation of cracks in the silo walls. From the original small units, silos have become larger and today are built with capacities up to about 60,000 tonnes of sugar.

Advantages

Tower silos only require about one-fifth of the area needed for conventional flat sugar silos for the same capacity. Silo operation is fully automatic and the consumption quality of stored sugar may be preserved over years.

Construction in reinforced concrete is more common than other types, an important reason being that the necessary building materials are readily available in developing countries. This is not the case with silos of steel sheet construction where higher investment costs are involved for material, transport and protection.

Operational sequence

Figure 2 shows a schematic drawing of the standard design of white sugar silo plant, where the product stored is transported from the factory by belt conveyor via a connecting bridge to the silo. The sugar is weighed in scales and transported by elevator buckets to the top of the silo. From there it travels on rotating belt conveyors and drops through slots in the intermediate platform, being thus continuously distributed over the cross-section area of the silo (Figure 3). This method of distribution is favourable for the behaviour of the sugar during the storage period, improving flowability when sugar is withdrawn from the silo bottom. In the silo basement the sugar is extracted from the discharging holes according to requirements and is re-transported on belt conveyors and a bucket elevator to a belt in the connecting bridge and from there to the packing station within the factory.

By means of concentric partition walls, sugar of two or three different qualities may be separated and stored simultaneously. It is obvious that this

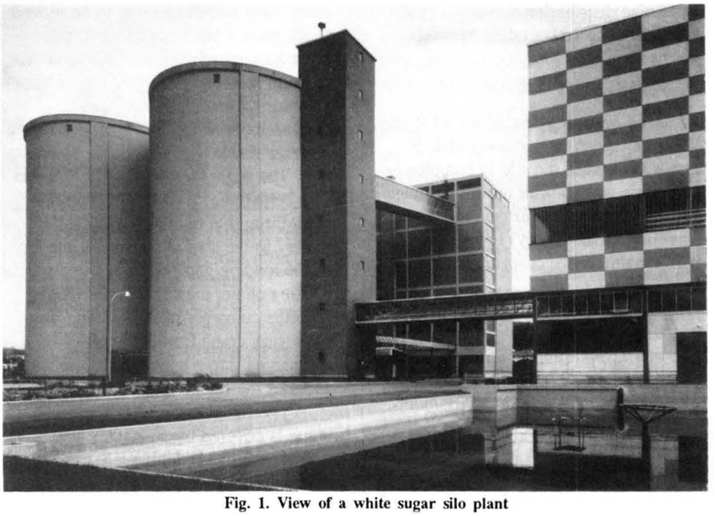


Fig. 1. View of a white sugar silo plant

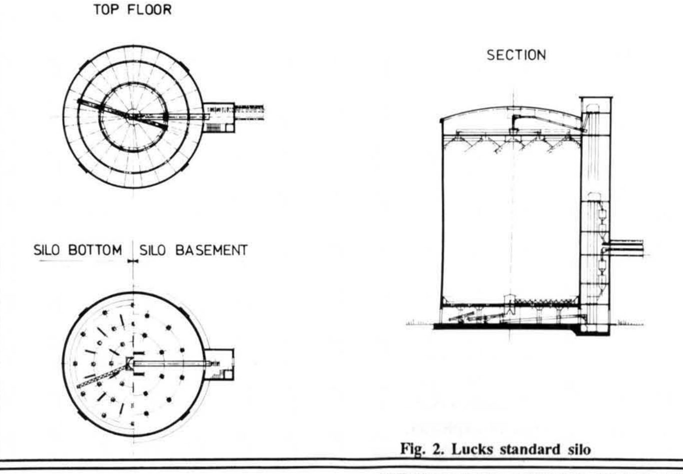


Fig. 2. Lucks standard silo

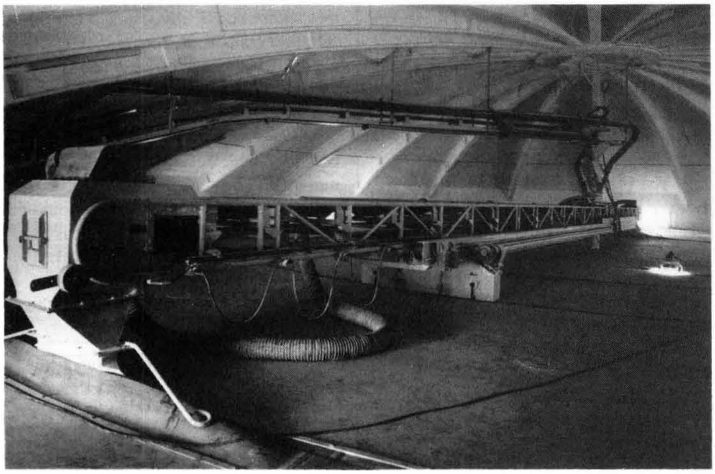


Fig. 3. Rotating belt conveyors on the top floor

method has advantages compared with the use of two smaller separate silos with regard to investment costs and operation.

Besides their standard design Lucks & Co. GmbH have developed another silo system which meets demand for a reduction of investment costs. Figure 4 shows such a white sugar silo; it has no charging platform or discharge basement; instead there is a closed charging bridge with a feed scroll in the upper section and a discharging channel and residual discharge scroll in the lower area.

Charging is effected centrally by means of the feed scroll which provides for an even distribution in the silo during charging.

Discharge takes place to approx. 80% through the centre of the silo by gravity. The residual scroll conveyor transports the remaining residues on the rims into the silo centre for further transport onto a belt conveyor which ends at the elevator tower. Combinations of both systems are possible and have been put into practice for a large number of cases.

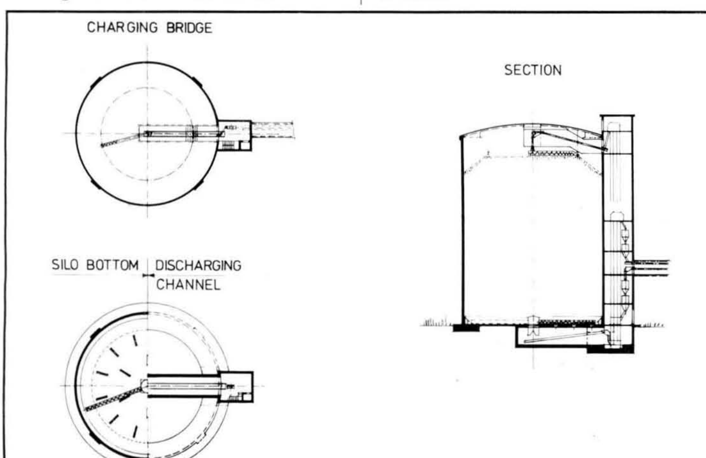


Fig. 4.

The Lucks standard design

The silo substructure, approx. 3 m high, is erected over the foundation and has a ceiling approx. 60 cm thick which is at the same time the floor of the storage bin. The whole substructure is constructed *in situ*. The walls of the substructure are approx. 30 cm thick and the ceiling rests on columns as required by static analysis and the distribution of the mechanical equpment.

The silo wall is built in prestressed reinforced concrete slipform work without interruptions. The calculated pre-stressing of the tension rings ranges from about 40 tonnes to 120 tonnes per tensile cable, depending on the size of the silos. The silo shell "grows" normally 3.4 - 4.0 m per 24 hours, so that the actual visible silo shell is built within 2 weeks, which has surprised many a spectator seeing this technically interesting building method. The actual building unit is completed by the platform covering the storage bin and the domed roof over the whole.

The stored sugar, owing to its hygroscopic characteristics, makes high demands on the insulation of the storage space proper and the air conditioning treatment during the storage period. While the storage space is limited at the bottom and top by a heated basement and a heated attic, where there is a constant temperature of approx. 20°C, the external walls must be provided with insulating sheets and water-repellent plastic plaster so that adequate protection against inclement ambient weather conditions is guaranteed. Since the sugar has characteristics incompatible with concrete, the inside surface of the silo wall is provided with a special two-component coating which prevents damage to the reinforced concrete wall, is of food-grade quality and furthermore withstands the high abrasion forces acting on the wall during discharge of sugar.

Intermediate platform

The intermediate platform with circular openings or slots for charging over the whole surface area is provided for the installation of mechanical equipment enabling nearly complete utilization of the storage capacity in the silo bin.

Usually the floor consists of a supporting construction in reinforced concrete or structural steel covered with prefabricated concrete slabs. The floor is finished off with cement screed and a plastic floor coating.

Extensive use of precast reinforced concrete elements is quite usual in the construction industry. It is economical to design such supporting construction in a radial or tangential form, as prefabricated reinforced concrete units, and assemble them with the aid of suitable erection equipment.

In the case of larger diameter silos, a reinforced concrete centre column of approximately 4 metres diameter has to be provided as an auxiliary support. Recently a supporting structure of honeycomb steel joists (to save weight) has often been chosen as an alternative. This steelwork is assembled on the silo floor and can either be taken up with the slipform or lifted on completion of the silo wall. The cladding of this intermediate floor and the roof construction is of pumice stone concrete slabs pre-cut to trapezoidal shape and laid on radial beams.

An intermediate platform is preferable to a charging bridge for reasons of hygiene and transport technology and also because available storage space can be better utilized. The platform also provides a double protection for the storage bin against weather as leakages in the roof covering can be readily located. As the inlets are individually charged by a rotating conveyor belt moving clockwise around the centre of the silo, it is necessary that the space above the intermediate platform is totally free of stanchions and columns.

Roof construction

Normally the roofs of white sugar silos are of ribbed-dome construction, in conical broach form or as domed slabs in reinforced concrete. The use of radial, bent or straight ribs in structural steel or reinforced concrete demands, as in the case of the intermediate platform, the application of suitable lifting equipment. The horizontal forces arising from the dome-shaped unsupported roof construction are carried by a circular tensile beam which is firmly connected to the top edge of the silo wall and thus gives the latter the required stiffness.

The breeze concrete slabs of the roof are covered with bitumen-bound, gristed cork sheeting, or some other suitable insulating material, and provided with welded plastic sheeting as roof seal.

Air conditioning and dust extraction

The oft-mentioned fear of explosions in sugar silos due to the concentration of dust can be overcome by careful dust collection from the storage space and from all transfer points in the conveying elements.

The stored sugar is conditioned by a special system of ventilation. The system used in German silos and numerous installations abroad is based on the fact that the whole storage volume is ventilated by filtered and conditioned air. In order to economize energy requirements, the warm air leaving the sugar at the top of the storage space can be sucked off through a piping system, then filtered and led back to the conditioning plant for recirculation. In countries or regions with longer periods of high relative humidity or when recirculating, the air which is to be blown into the silo can be dehydrated. The quantity of air is chosen in such a way that the air in the storage space is exchanged approximately every two hours.

Electro-mechanical equipment

The electro-mechanical equipment of the sugar silo is partially conventional, and partially special conveying elements which have been developed to meet the particular requirements of a sugar silo. All equipment and building sections which may come into contact with the sugar are in food-grade materials.

Quality of sugar to be stored

Certain demands have to be made on the properties of the sugar to be stored; these, however, can usually be met without difficulty. Thus, the moisture content of the sugar should normally not exceed 0.04% and is limited to a maximum of 0.05% by weight. Furthermore, the grain size distribution should not impede the air conditioning, i.e. fine grain under 0.02 mm should be screened-off and over-size grain larger than 1 mm in size should be crumbled. The advantage gained is that the sugar from the silo can be packed in normal commercial sizes and be marketed in other various forms without any after treatment.

Special features of the standard design Lucks white sugar silo include:

the silo can be charged and discharged simultaneously;

mechanical equipment is easily accessible external to the silo storage space;

the sugar is handled carefully on entry and extraction because the force of gravity is generally used for this procedure;

the elevator tower outside the silo bin provides space for the bucket elevators, stairs and lift and facilitates the installation of weighing units, daily bins and sometimes dust filters, together

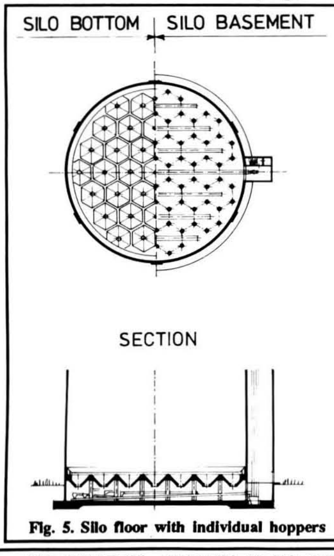


Fig. 5. Silo floor with individual hoppers

White sugar silos in concrete construction

with the disposition of bulk loading equipment and a connexion at a suitable level for further processing in other production stations; and

extension is possible by providing further silos on the periphery of the original silo plant, additional elevators being unnecessary.

The system follows a straight forward basic concept, proven over 30 years, which limits the mechanical equipment to an essential minimum and provides a most economical form of sugar storage in large-volume silos.

Conclusions and future prospects

The development of sugar silos in a massive type of construction does not stand still. Silos designed by Lucks & Co in recent times have been provided with individual hoppers distributed over the complete floor area, thus optimizing the flow behaviour of sugar during discharge (Figure 5).

Modern technology and the high cost of energy consumption promote new ideas which extend to the investigation of wall heating, heat recovery, and further improved heat insulation among other aspects.

Facts and figures

Nepal sugar factory expansion[1]

The Birgunj sugar factory is to spend about 30 million rupees (approx. £1,000,000) towards the renovation and maintenance of its factory machinery and premises. An equipment and works contract to this effect has been signed with the China Machineries Export & Import Co. The project is planned to be completed in 18 months. The factory, which was established in 1962, has a crushing capacity of 1500 t.c.d, which will be increased by one-third after the renovation.

Nigeria sugar expansion program[2]

Nigeria expects to develop a program to achieve a target of 500,000 tonnes of sugar by 1990. The main parts of the program would be: rehabilitation of the cane plantations and of existing factories to increase production to 170,000 tonnes; progressive increase of production by an additional 130,000 tonnes; and building of four new units to produce an additional 200,000 tonnes.

Portugal sugar production[3]

Beet sugar production in the Azores in 1985 amounted to 3205 tonnes, white value, down from 6000 tonnes produced in 1984. Portuguese raw sugar imports in 1985 reached 331,500 tonnes, mainly from Swaziland, Brazil, Réunion, Cuba and Zimbabwe. In view of the EEC production quota of 60,000 tonnes allocated to continental Portugal, the authorities are continuing with trial plantings of sugar beets in different regions of the country, mainly in Ribatejo, Allantejo and in the Mondago Valley.

Spanish bid for Itallian sugar factories[4]

A 3-member Spanish consortium is negotiating the purchase of four of Maraldi S.p.A.'s five sugar factories with a total of 120,000 tonnes annual capacity. The Spanish firms are Ebro Cía. de Azucares y Alcoholes S.A., Sociedad General Azucarera de España S.A. and Cía. de Industrias Agrícolas S.A. which between them account for 75% of the Spanish sugar industry's turnover and own 25 of the country's 29 beet sugar factories.

Japan sugar refining capacity cut[5]

The Japanese sugar refining industry has cut its refining capacity by 630,000 tonnes/year under a three-year restructuring scheme which expired at the end of October. Under the government-backed scheme, the industry was due to cut back annual capacity by 1 million tonnes from 3.81 million tonnes, in an effort to avoid excessive competition amongst refiners brought about by the steady decline in Japanese raw sugar imports. Although this target has not been met, the Ministry will continue to seek cuts in capacity as domestic consumption and imports decline. The sugar beet crop is estimated at 3.89 million tonnes, down from 3.92 million tonnes in 1985, owing to a reduction in the beet area from 72,500 to 72,100 ha.

Malaysia sugar project[6]

The Commonwealth Development Corporation has made a loan of £5,000,000 to Gula Pading Terap Bhd. of Malaysia for the development of a 8900-hectare sugar cane plantation in Kedah state, complete with mill and refinery, to employ more than 2000 people.

Indian studies on alcohol from sugar cane[7]

The Indian Council of Agricultural Research initiated studies in 1979 to standardize technology for the production of alcohol directly from cane juice. The first part of the project, conducted at the Sugarcane Breeding Institute in Coimbatore, was to develop agricultural practices to increase the productivity of cane whereby a maximum quantity of alcohol could be obtained per hectare of the crop. The second part was to standardize the processes for clarification, fermentation and distillation and was carried out at the National Sugar Institute in Kanpur, and it was found possible to produce from 9000 to 12,600 litres of alcohol per hectare. Technico-economic feasibility and commercial viability of the appropriate technology developed is to be studied at Sakthi Sugars, in Tamil Nadu, during the current sugar season.

Bulk handling increase in Cuba[8]

Nine more sugar factories in Cuba are to be converted to bulk sugar handling for the 1986/87 season; this will reduce to only 700,000 tonnes the Cuban production still packed in jute sacks; total production in 1985/86 was 7.25 million tonnes.

Trinidad alcohol project[9]

The government of Trinidad recently approved a plan to build a distillery with an annual capacity of 20 million gallons; the raw material will be basically cane sugar and molasses. It will be the first of its type in the country.

US quota freeze turned down[10]

The proposed amendment aimed at adjusting US sugar import quotas in favour of Caribbean countries, Ecuador and the Philippines[11] and barring imports from countries which produced narcotics or imported Cuban sugar is unlikely to pass after meeting resistance in Congress. The US trade representative and the Secretary of Agriculture told Congress in a letter that the amendment could have "highly negative political and economic implications" for traditional suppliers such as Canada and Australia as well as many developing countries.

Tanzania sugar imports[12]

Owing to large unsatisfied domestic demand, Tanzania is unable to continue exports of sugar to the EEC and has imported 20,000 tonnes for the first time in many years. Production is expected to stabilize around 120,000 tonnes over the next several years, which will continue to leave shortages on the local market.

1 *Standard Chartered Review*, September 1986, 27.
2 *Amerop-Westway Newsletter*, 1986, (154), 10.
3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 497.
4 *Public Ledger's Commodity Week*, October 11, 1986.
5 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 526 - 527.
6 *World Commodity J.*, 1986, **9**, (2), 14.
7 *Sugar Scene*, 1986, **4**, (9), 6.
8 *Reuter Sugar Newsletter*, September 19, 1986.
9 *GEPLACEA Bull.*, 1986, **3**, (9), Inf.-6.
10 *The Times*, October 10, 1986.
11 *I.S.J.*, 1986, **88**, 202.
12 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 565.

Bury Packaging Complex

By T. A. Field and H. S. MacLeod
(British Sugar plc, Bury St. Edmunds, Suffolk, England)

The Bury St. Edmunds Packaging Complex, as a packaging, warehousing and distribution complex for 1 kg packets of granulated sugar, produced a number of "firsts" for British Sugar. It was the first "greenfield" siting of a production plant since the formation of British Sugar – in fact, since the last factories were built in the late 1920's; the first custom-built packaging plant and warehouse, and the first fully automated, computer-controlled warehouse for pallet loads of packeted sugar, using high bay racking with double-reach narrow aisle cranes (Figure 1).

It was the first use of empty pallet inspection, drying and storage facilities, the first use of an automatic data collection system for the weight of every packet produced, and the first installation of a fire control sprinkler system.

Rationalization within the company had led to the closure of four factories. Of these, three factories had packeting plants producing 1 kg packets of granulated sugar totalling 3550 tonnes/week or 166,850 tonnes/year.

To replace this production capacity and to allow for an increase of output, instead of increasing the capacity of the remaining packeting plants in a piecemeal fashion, it was decided to build a single new plant capable of producing about 200,000 tonnes/year of 1 kg granulated packets of which 150,000 tonnes would be in 15 × 1 kg paper parcels on pallets and 50,000 tonnes where the packets were put straight on to pallets without parcelling and the pallet load stretch-wrapped.

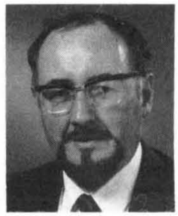
Warehousing capacity was to be provided for four weeks production plus pallet loads of special sugars brought in from other plants, i.e. 16,000 tonnes of granulated packets and 4000 tonnes of "specials".

The plant was to act as a main distribution centre for the domestic trade to serve shop deliveries over a wide local area and to send packeted granulated sugar to depots spread over a very wide area of the UK.

The plant

The relationship between the Bury

T. A. Field



H. S. MacLeod

factory and the Bury Packeting Complex is like the relationship between manufacturer and customer. The factory produces and stores in silos 140,000 tonnes of sugar per year and receives from other factories up to another 60,000 tonnes to supply and "sell" to the Complex – a total of 200,000 tonnes each year.

In fact, the Complex's plant starts with the bulk sugar weigher within the cubing building belonging to the factory. It is at this weigher that the "selling" transaction takes place. From the weigher, a 70 tonnes/hr conveyor takes the sugar across a tubular bridge (Figure 2), spanning the boundary fence between the two sites, to feed an air-conditioned 500 tonnes steel silo within the sugar handling building in the Complex.

Reclaimed from the bottom of the silo, the sugar is elevated and then split into two streams over magnetic separators, each stream over a Locker scalping screen. Then each stream is

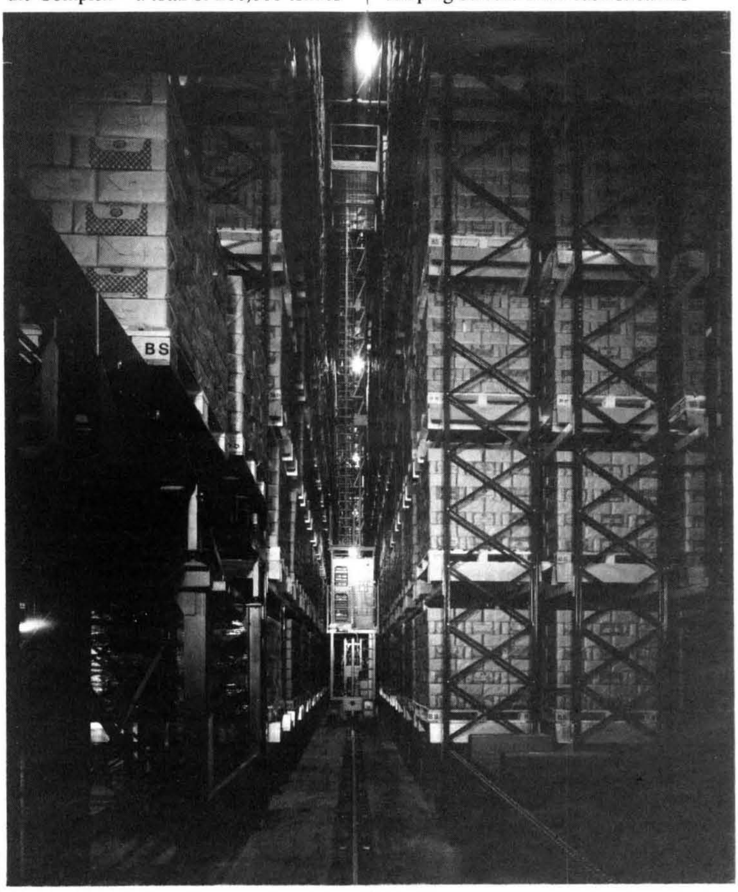
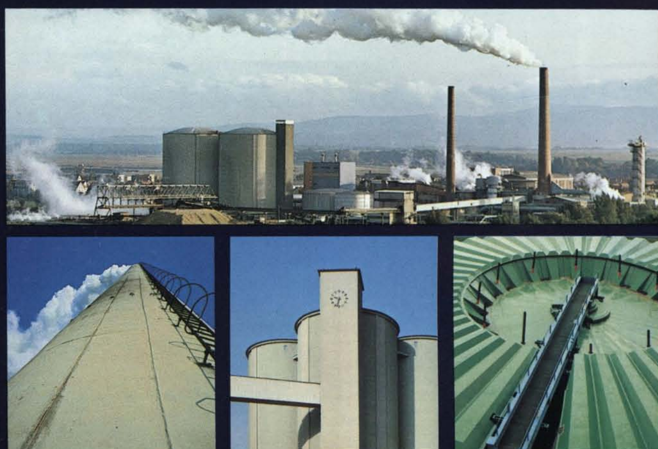


Fig. 1. The high bay warehouse

LUCKS+CO worldwide required



General activities

Each 30th kilogram worldwide and 90 % of the German yearly sugar consumption have passed a LUCKS white sugar silo. This achievement speaks for itself. New plants, rehabilitations and modernizations of industrial plants for the sugar industry are unthinkable without the contribution of experienced architects and civil engineers. The experts of LUCKS + CO are well prepared to give their advice for any requirement and offer the execution of the following works:

- white sugar and beet silos
- smokestacks
- refractory works
- clarification plants
- industrial constructions

LUCKS' facilities for project execution are at the disposal of clients and partners.

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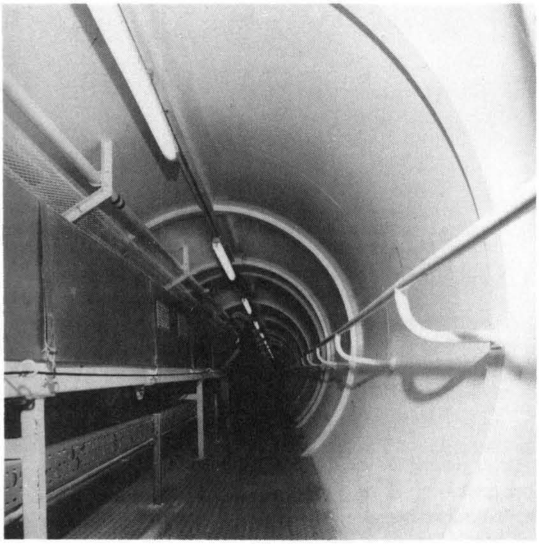


Fig. 2

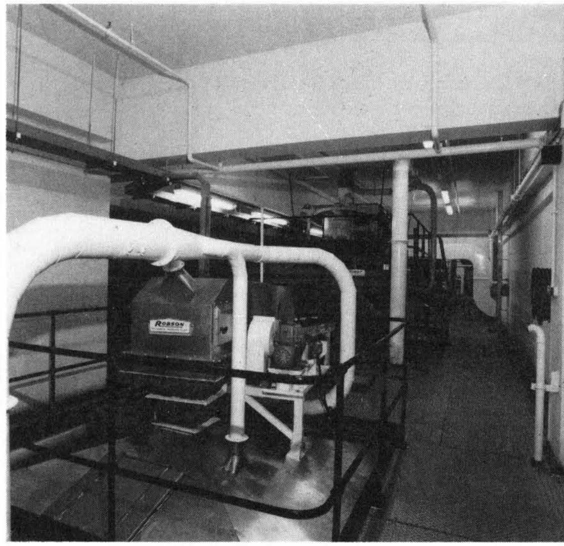


Fig. 3. Main distribution and screening system

split again into a total of four intermediate bins, each bin with two outlets, thus feeding eight conveyors, each conveyor finally discharging into a bin over a packaging machine (Figure 3).

On the packaging floor, which is one floor up from ground level, each Hesser machine is in a "U" layout – right angle paper feed into the 270° use of the packet forming mandrel, the packet is discharged into a pocket conveyor (which is cantilevered out from the moving parts of the machine to reduce sugar spillage on to those moving parts) where it is filled from one of a quadruple set of weighers, the packet vibrated, check-weighed, the top trimmed, folded and glued and then discharged, via a top dry-ing belt, at right angles to the machine.

Nos. 1 to 4 Hesser machines have twin discharges where half or full output can go either to a parcelling machine or straight to a packet palletizer. This is to give both versatility of production and to maintain a parcelling machine ticking over at half rate so that, if a stoppage occurs on the packet palletizer, full production can immediately be switched to parcelling.

Nos. 5 to 8 Hesser machines only feed parcelling machines. The in-built checkweigher on each Hesser packer serves three functions: to act as a "policeman" and throw out over- and under-weight packets; to give feed-back weight correction signals to each weigher; and to pass weight information to the central data collection point where the weight of every packet produced, standard deviations of weight spread, etc., are recorded and retained.

From the packing machines, all packets pass through metal detectors.

Each parcelling machine, wrapping 15 × 1 kg packets, discharges down a spiral chute to conveyors running under the ceiling of the ground floor. The eight lines feed into three conveyor streams, each stream feeding any combination of

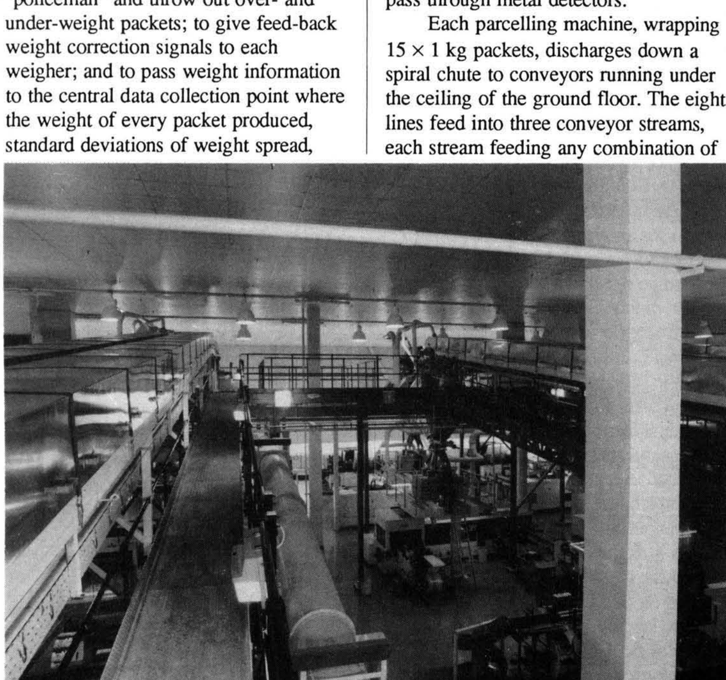


Fig. 4. View of the packaging hall showing feed conveyor to individual packaging machines

three parcel palletizers, although two palletizers normally take the whole output of parcels.

Hesser machines 1 and 2 feed single packets, either at 55 per minute from each machine or 110 per minute from a single machine, to No. 1 Kettner packet palletizer. Similarly, machines 3 and 4 feed No. 2 Kettner. Single packets are palletized onto 1065 mm square pallets with 70 packets per layer, 14 layers high (the machine may be programmed for 15 layers also) with stabilizing interleaving paper every fourth layer. The output of stacked pallets from both Kettner palletizers is combined to be automatically stretch-wrapped (Figure 5).

The random output of both parcel and packet palletized loads then passes, via a pallet gauge station (to check the load for squareness) into the warehouse. As the loads move by conveyor in the warehouse, sensors determine the type of load which is noted by the computer.

The loads are programmed to go to a predetermined station servicing one of the cranes. From this station, the crane puts the pallet load into an empty space in the racking and the computer, having determined the space, records where that pallet is, the type of pallet load and when it was put into the racking.

Having completed a command, the crane waits until the next order which could be to either go back to the pick-up station for another pallet to be put into the racking or to take a pallet load out of store to be put down on to a different station which feeds pallets to the loading out area for despatch. The whole system of storage runs on a "first-in/first-out" principle. The only manual input into the computer is the keying-in of individual lorry loads for despatch. For instance, a lorry is known to be coming in to load 20 pallet loads of sugar so this information, together with the loading bay number, is keyed in and, as the lorry arrives, it is directed to the right loading bay where the 20 loaded pallets will be waiting on that particular conveyor serving that loading bay. It is only at this point, for the first time, that the sugar, the packets, the parcels, the pallets are "manhandled" the short distance between conveyor and lorry by fork truck.

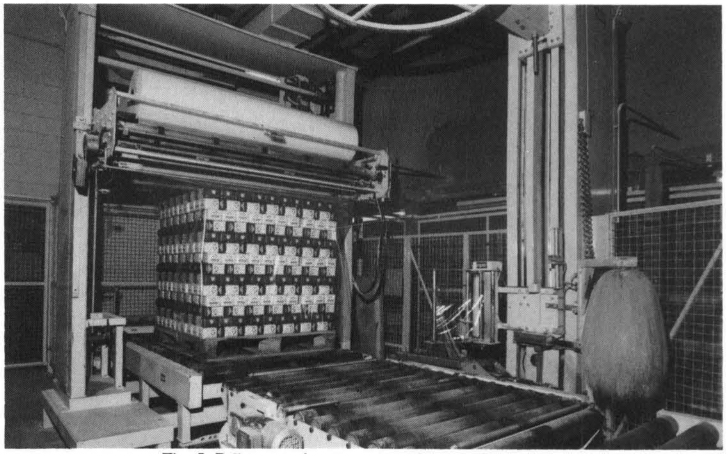


Fig. 5. Pallets entering the automatic wrapping machine

Special sugars, imported from other factories on pallets, are all handled by fork trucks. These pallet loads are put into low level racking in the warehouse and are then used to make up part loads of mixed sugars for multi-drop distribution within the Bury delivery area, whereas the full loads of granulated packets are sent, by long-distance lorries, to serve depots over the whole of Southern England and South Wales.

Ancillary equipment

Great attention is paid to the condition of pallets. A separate pallet store houses a pallet drying oven for the drying of new pallets made of Portuguese pine of high moisture content and for drying returned pallets that have been outside in wet conditions. Also there is a pallet inspection machine

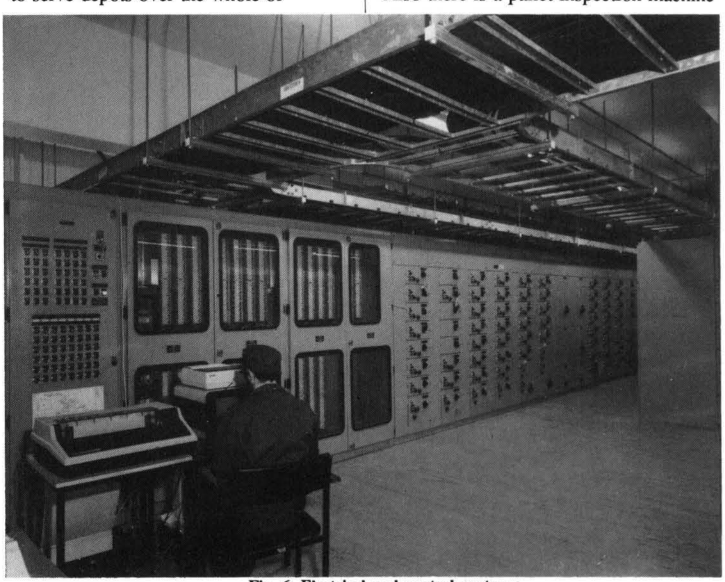


Fig. 6. Electrical and control centre

ISJ Abstracts

Cane sugar manufacture

Studies on ion exchange resins for cane syrup decolorization

W. F. Lin. *Taiwan Sugar*, 1986, **33**, (1), 20 - 24.

See *I.S.J.*, 1986, **88**, (*Rpt. Taiwan Sugar Res. Inst.*, 1985, (108), 35 - 43).

Parameter to evaluate staleness in harvested sugar cane: reducing sugars

A. Kumar, P. Sachdeva and A. P. Gupta. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, Ag.77 - Ag. 84.

Analysis of cane juice for Brix, pol, purity, reducing sugars, recoverable sugar and total losses showed that the reducing sugars content was a reliable guide to staleness of the cane, which had been stored for up to 96 hours. Evaluation of cane staleness and possible rejection of unsuitable cane would reduce losses in the factory.

An instant indicator for bulk density

P. G. Sankalecha, A. M. Baranth, P. F. Jain and S. P. Pandit. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.1 - E. 6 + diagram.

The bulk density of prepared cane is determined by a piston which compresses a 1 kg sample for 20 seconds at a constant applied pressure; the travel of the piston is indicated by a pointer and a scale. Tables of bulk density and % ruptured cells at different fibre contents may be used as ready reckoners.

Combined effect of hot water imbibition and roller surface treatment

H. L. Verma, S. K. Ghosh, P. S. Srivastava and N. C. Agarwal. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.7 - E. 15.

The benefits of hot water imbibition at 85°C and mill roller treatment to give a roughened surface were demonstrated by a reduction in bagasse pol and moisture content, a rise in mixed juice and final bagasse temperature and a reduction in the purity drop from primary to mixed juice compared with previous results.

Instrumentation and automation of a coal-fired boiler at Ponni Sugars and Chemicals Ltd.

B. S. Gurumurthy, N. Gunasekaran and S. Srinivasan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.29 - E.37.

Details are given of the instrumentation and automatic controls of the bagasse furnace at this new factory.

Increasing the cooling efficiency of mill turbine oil coolers by using less water

S. Dhayanandhan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.40 - E.44.

Because the mean temperature of the oil used as coolant for the turbo-set at the author's factory was too low, as was that of air used to cool the alternator, consumption of the cooling water used for treatment of the oil and air was excessive, and it was decided to allow the temperature of the coolants to rise slightly and thereby save water. Diagrams illustrate the problem and its remedy.

Use of aluminium tubes on secondary juice heaters and a vapour cell

S. C. Arora and K. K. Phutella. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.65 - E.67.

The replacement with aluminium tubes of brass tubes in primary juice heaters in 1980 and of the mild steel tubes in secondary juice heaters in 1981 and 1983 is reported. Despite a juice pH of 8.3 - 8.5, the tubes have performed well, with no major leaks. The fact that they are expected to last only about six years is not considered a major drawback in view of their relatively low cost and high conductivity (which has led to a fall in steam consumption). From results of use of an aluminium tube in a vapour cell it has been decided to replace all of the mild steel tubes with aluminium ones. The loss in weight of aluminium tubes resulting from use is shown.

Improvement in shredder performance

D. R. Patil. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.45 - E.50.

Modifications to the cane preparation system at the author's sugar factory included using a reverse cutter as gravity feeder to a shredder installed midway between cane carriers Nos. 1 and 2. By comparison with the previous system, the new scheme works smoothly, with all the shredder's rotation being used to prepare the cane. Sticking of hammers so that they failed to pivot was prevented by providing spacers between the discs carrying the hammers.

A continuous mill wet bagasse dryer

S. C. Bose, V. K. Rohatgi, G. Kumar, B. R. Dhingra and B. K. Mishra. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.51 - E.63.

An account is given of a continuous bagasse dryer which was installed at Daurala in 1982. Details are given of its performance over three years, showing an average 7 units reduction in the bagasse moisture to 42 - 43% at an hourly throughput of 10 tonnes. Calculation of the economics indicates an amortization period of about three years.

Thermal economy for maximum conservation of bagasse

S. K. Ghosh. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.69 - E.76.

After discussing the benefits of reducing bagasse consumption as fuel so as to provide the maximum possible for use in paper production, the author examines reasons for the reluctance of sugar factory operators to use coal instead of bagasse and then calculates that the steam requirements of a factory crushing 2000 tcd could be met by burning only 20% bagasse on cane (assuming an average 33% of the cane available as bagasse).

Effect of design variables on vacuum pan performance – a computer study

H. N. Gupta. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India,* 1984, E.77 - E.86.

While tube diameter and length and downtake diameter are the main design parameters of a vacuum pan, they affect other variables involved in producing an acceptable design, and the author has used a computer to evaluate the various design constraints. From this exercise it is concluded that tube length is the factor requiring closest consideration, while all the design parameters should be selected to provide minimum pressure head and head loss.

Actual *C*-massecuite % cane to ideal *C*-massecuite % cane

A. R. Sali. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India,* 1984, M.9 - M.13.

Two indicators of boiling house efficiency are suggested: (1) the ratio of actual to theoretical *C*-massecuite % cane crushed × 100, where the theoretical value is given as 100 (non-sugars in clear juice % cane/non-sugars % *C*-massecuite), and (2) the purity of *C*-sugar from the fore-workers. Worked examples are given of the calculations.

A case study on the rearrangement of evaporators for reduced steam consumption

R. Thirunarayanan, J. Gurugovind and A. G. Dhananjayan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India,* 1984, M.15 - M.42.

The crushing rate at the authors' factory was gradually expanded from 800 to 2200 tcd over several years, but in 1980/81 the rate fell to a very low level because of poor cane supplies, and the shortage of bagasse created the need for extra fuel. The problem was solved by modifying the evaporator, which consisted of a vapour cell of 9000 ft^2, a 1st effect of 6000 ft^2, two 2nd and two 3rd effects each of 3000 ft^2 and a 4th effect of 6000 ft^2; one each of the 2nd and 3rd effects was eliminated and the vapour cell used only when the maximum crushing rate was achieved, in which case vapour from it is bled to the pans and secondary juice heaters while 2nd effect vapour is bled to the raw juice heaters; otherwise, when the crushing rate is 800 - 1400 tcd, the vapour for the pans and raw juice heaters is bled from the 1st effect, while the vapour is bled to the pans from the 1st effect and that to the raw juice heaters from the 2nd effect when the crushing rate is 1800 tcd. In all cases, there is a bagasse saving as shown by balances for the various schemes.

Some aspects of the adsorption of colorants by mud produced during cane juice clarification studies undertaken with caramels and melanoidin

S. C. Sharma and P. C. Johary. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India,* 1984, M.67 - M.80.

Investigations of colorant adsorption during defecation, sulphitation and carbonatation showed that 1st carbonatation mud could adsorb greater quantities than the mud from the other two processes, and that the specially prepared caramels were adsorbed to a much greater extent than melanoidin. A study of the effect of two heating stages on adsorption of one of the caramels in sulphitation showed that adsorption was maximum at 70 - 72°C in the 1st stage and fell with a reduction in temperature, whereas in the 2nd stage maximum adsorption occurred at 93 - 95°C and fell with further temperature rise; however, although optimization of the temperature increased adsorption, it was still much lower than in carbonatation (in which the optimal initial temperature was 50 - 55°C) but well above that obtained with defecation. The optimum pH was 6.7 - 7.0 in defecation and sulphitation, and 10.5 - 10.8 in 1st carbonatation. Presulphitation at pH 4.5 caused a slight improvement in colorant adsorption during main sulphitation, but preliming at pH 7 had no effect.

Evaluation of the heating surface and operational parameters of a multiple-effect evaporator in general by the pressure drop concept

B. K. Shukla. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India,* 1984, M.125 - M.143.

A mathematical expression has been derived which relates the pressure drop in the individual evaporator effects and the total pressure drop to total evaporation; it is intended to facilitate evaluation of operation parameters where the heating surface areas of the individual effects are identical or differ and where vapour is bled from one or more effects.

Studies on the settling and thickening efficiency of a polyacrylamide flocculant for sugar cane juice clarification

S. Bhatt, R. P. Shukla and S. Bose. *Proc. 48th Ann. Conv. Sugar Tech. India,* 1984, G.9 - G.22.

Superfloc A, a flocculant made in India, was tested on limed and sulphitated juice. Results showed that 1 - 3 ppm of the polyacrylamide gave settling rates and mud volumes similar to those given by the same dose of Separan AP-30 which, however, gave better juice clarity.

Direct analysis of cane for payment – method followed in Guadeloupe

R. Lokan. *Bharatiya Siugar,* 1986, **11,** (4), 13, 15 - 16.

Descriptions are given of the three types of cane sampler used in Guadeloupe and of the analysis technique used for cane payment. The possibility of adopting the system in India is discussed.

Beet sugar manufacture

Washing with syrup in batch centrifugals

P. Mosel, H. R. Kemter and T. Cronewitz. *Zuckerind.*, 1986, **111**, 211 - 216 (*German*).

Investigations on the effect of washing with syrup are reported and a scheme based on the results and developed at Plattling sugar factory is described. For raw sugar washing in a batch machine, three syrups were tested (the run-off from the washing, thick juice and melt liquor, of 89, 92 and >99 purity, respectively) after adjustment to 70°Bx and 70°C; 2 - 18% of each syrup was used on massecuite. At the lower application rates, the ash content of the sugar was much higher than when water was used as washing medium at 2% on massecuite, and rose as the syrup purity was lower; however, at approx. 15% on massecuite, the melt liquor gave only slightly poorer results than water. Use of 18% run-off from the washing, followed by 2% water (representing about 60% of the water when used alone), gave the same sugar purity as did water washing alone, but increased crystal yield. The amount of wash syrup required for a given sugar ash content rose with increase in Brix and with fall in temperature. Similar results were obtained in the washing of white sugar. In general, use of syrup reduced wash water consumption by about one-third and thus decreased the amounts of massecuite and hence steam consumption. The increase in crystal yield could be as much as 13% when a combination of syrup and water was used to wash white sugar, and even without the water up to 6% more crystal was obtainable.

Fire protection in sugar factories

H. D. Beenken, D. Joest and R. Stein. *Zuckerind.*, 1986, **111**, 229 - 234 (*German*).

After a brief survey of major fires and the cost of damage caused in the West German sugar industry from 1967 to 1983, details are given of two dust explosions that occurred in 1982, one at Boiry Ste. Rictrude factory in France and the other at Raffinerie Tirlemontoise in Belgium. The devastating effects of dust explosions and the associated outbreak of fire are stressed. Advice on fire prevention and on tackling a blaze are discussed on the strength of guidelines issued by insurers, covering electrical installations, dust separation, beet pulp drying and pelleting, boiler plant and conveyors. The need for adequate alarm systems and for well-organized fire-fighting arrangements is emphasized, and details given of discounts on insurance premiums that are available where recognized preventive measures have been adopted.

Calculation of a boiling house scheme

J. Gerse and L. Megyeri. *Cukoripar*, 1986, **39**, 6 - 11 (*Hungarian*).

Details are given of a computer program developed from a mathematical model of a 3-massecuite boiling scheme. It allows greater flexibility in calculation of schemes aimed at minimizing the amount of massecuite in circulation. Manipulation of the operational parameters based on thick juice purities between 86 and 92 is demonstrated by tabulated data.

A popular approach to the energy question

P. Wertán. *Cukoripar*, 1986, **39**, 20 - 22 (*Hungarian*).

The question of energy consumption in sugar manufacture is discussed against the background of the general upward trend in oil prices after 1973. After indicating the amount of energy consumed in beet processing, the author briefly considers the role of the evaporator and examines ways in which steam consumption could be reduced. The average thick juice Brix in Hungary in 1984/85 was 60 - 61°, ranging from 55° to 63°, which resulted in a relatively large amount of water still to be removed in the vacuum pans. While it would be of great benefit for the sake of steam economy to raise the Brix to 70° in the evaporator, such juice would be difficult to boil; however, a Brix of 68° is considered more practical and would ensure that the burden of removing the major part of the water would fall on the evaporator. Automatic control of boiling would reduce fuel consumption by 0.1 - 0.3% on beet as a result of optimization, but it is stressed that, as indicated by Parádi & Hegyessy[1], the thick juice must have a minimum purity of 88.

Results of commissioning trials at Sabac sugar factory, Yugoslavia

Z. Pochyly. *Listy Cukr.*, 1986, **102**, 63 - 64 (*Czech*).

The results achieved during 10 days' commissioning trials at Sabac (a factory supplied by Czechoslovakia for a rated slice of 4000 tonnes/day) are reported and compared with the guarantees set out in the contract, showing that performance was satisfactory in respect of daily slice, consumption of fuel, steam, power, lime, sulphur, etc., total losses and molasses losses, crystal quality and moisture content, and heat consumption in pulp drying.

The effect of lime consumption on the action of polyacrylamide during juice settling

K. P. Zakharov, V. Z. Semenenko and L. D. Dotsenko. *Sakhar Prom.*, 1986, (4), 22 - 23 (*Russian*).

Investigations showed that the positive effect of polyacrylamide flocculant on 1st carbonatation juice settling velocity was greater than when the amount of lime added exceeded 80% on non-sugars than when it was below 80%; the effect of the flocculant was also enhanced by activation with Na_3PO_4 at a 1:2 flocculant:phosphate ratio but was only slightly affected by NaOH in some cases, while much better results were obtained by preparing the flocculant by two hours mixing in hot (95°C) water than in warm (50°C) water. The effect of the higher lime level is explained in terms of the electrical charge on the flocculant and unfiltered juice particles,

1 *I. S. J.*, 1986, **88**, 39A.

with the Ca^{++} ions acting as a bridge bond between the flocculant and $CaCO_3$ particles.

Intensification of the diffusion process by treating the juice-cossettes mixture in an electric field

M. A. Kupchik, A. B. Matvienko, V. V. Mank and I. M. Katrokha. *Sakhar. Prom*, 1986, (4), 23 - 26 (*Russian*).

Trials on diffusion in an electric field involved subjecting a 2 m high bed of cossettes to a voltage of 0 - 4 V/cm for up to 60 minutes in a special unit provided with aluminium electrodes. Optimum conditions were found to be a voltage of 1.8 - 2.0 V/cm and a time of 15 - 20 min, which increased the mass transfer coefficient by 170 - 190%.

Apparatus for liquid spray sulphitation of products in sugar manufacture

V. N. Shalatonov, O. V. Moroz, A. A. Lipets and A. P. Kozyavkin. *Sakhar. Prom.*, 1986, (4), 26 - 29 (*Russian*).

A pipeline sulphitation unit, designed for factories of less than 2000 tonnes/day beet slice and which is suitable for treatment of diffusion water, juice and syrup, has been installed in a number of factories and has given satisfactory results in tests at three of them. A description is given of the system and of an arrangement for diffusion water treatment.

Tests on an automated station of modified FiLS filter-thickeners for 1st carbonatation juice at Sambor sugar factory

Yu. V. Anikeev *et al. Sakhar. Prom.*, 1986, (4), 30 - 33 (*Russian*).

Details are given of automatic control of a station of 5, 7 or 8 FiLS filter-thickeners (for factory slices of 3000, 4500 and 6000 tonnes of beet/day, respectively) and results of trials at Sambor (handling an average of 3350 tonnes of beet/day) are reported; these showed the benefit of reduction in the filtration cycle time and decreased losses in filter cake and those caused by thermal and alkaline degradation, as well as a fall in filtrate turbidity and in filter cloth consumption.

Flaws in one scheme of tower diffuser automation

A. V. Ternovyi. *Sakhar. Prom.*, 1986, (4), 33 - 34 (*Russian*).

While a specially devised automatic control scheme for juice feed in the prescalder of a tower diffuser is based on a constant ratio between the quantity of juice fed to the cossettes mixer and that fed into the shaft of the prescalder (the level controller in the shaft reacting also to the juice entering the mixer), there has been sufficient fluctuation in the ratio to invalidate the system and cause screen blockage. Remedial measures are suggested.

The A2-POF clarifier-thickener with filter aid

A. M. Shcherbakov *et al. Sakhar. Prom.*, 1986, (4), 34 - 37 (*Russian*).

The A2-POF clarifier is available as a one-section model for a daily throughput of juice from 1500 tonnes of beet, or has two superposed sections for handling twice as much juice. It is cylindrical with a conical base, has a vertical central shaft, a juice-floc mixing chamber (to which the two components are fed via tangential ports) at the top of the clarifier (with an air and foam vent), a central juice distributor, a mud scraper below the floc-forming chamber and a central sump in the bottom conical section. The juice flows from the mixing chamber down the hollow sleeve surrounding the central shaft to a manifold; at the end of its ascent during subsequent treatment, it flows through tubes carried by a horizontal disc from which it drains to a peripheral gutter provided with four discharge pipes. A deep grid across the clarifier just above the juice distributor prevents turbulence in the ascending juice. Performance data from trials at a sugar factory indicate a clear juice mud content of 0.3 g/litre and a mud density of 1.15 - 1.19 g/cm³.

Automation of lime kiln charging at Chishmy sugar factory

A. A. Gotsun, V. I. Strel'nikov, A. A. Slavyanskii and V. A. Pugachev. *Sakhar. Prom.*, 1986, (4), 37 - 39 (*Russian*).

Details are given of the electrical circuit of a scheme for automatic control of lime kiln charging to a preset level.

Intensification of heat transfer in a ring duct when heating highly viscous fluids

V. F. Naumenko, V. A. Anistratenko, L. M. Khval'ko and A. V. Tokar'. *Sakhar. Prom.*, 1986, (4), 41 - 44 (*Russian*).

The principle of increasing heat transfer using wire rings on the inside and outside surfaces of ring ducts is described with the appropriate mathematics of thermodynamics, and application of the scheme to a fuel oil preheater (using steam as heating medium) at a sugar factory is described. Heat transfer was raised by 40 - 45% at an increase in friction flow resistance of only 20 - 25%.

Methods for increasing (sugar) manufacture

A. P. Parkhod'ko. *Sakhar. Prom.*, 1986, (4), 44 - 47 (*Russian*).

Descriptions are given of incorporation of new ideas in the normal sugar manufacturing process at various Soviet sugar factories, including: installation of a novel juice recirculation system for carbonatation and of a hydrocyclone for sand removal from 1st carbonatation juice before the settler; an alarm system indicating stoppage of a rake conveyor used to discharge exhausted cossettes from a tower diffuser; an automatic cut-out for the drive of a twin-scroll trough-type diffuser when the scrolls are misaligned; arrangements for separating beet and trash; alternative means for discharging exhausted cossettes from a tower diffuser; and various automatic control and monitoring systems that are briefly mentioned.

A block system for scroll-type diffusers

D. S. Tkach. *Sakhar. Prom.*, 1986, (4), 48 - 49 (*Russian*).

An outline is given of an automatic system for stopping the drive of a twin-scroll diffuser when the scrolls are out of alignment.

Manufacture of edible syrup

N. I. Shtangeeva, L. S. Danchuk and N. A. Arkhipovich. *Sakhar. Prom.*, 1986, (4), 54 - 55 (*Russian*).

Partially inverted edible syrup for use in various food industries can be obtained from thick juice in normal beet sugar manufacture by carbonatation, phosphatation, sulphitation, treatment with active carbon and concentration to 69 - 70°Bx; this treatment is less costly than cation exchange treatment of intermediate products. Details are given of experiments and of the results obtained.

Investigation of sugar losses in heat treatment of beet cossettes by steam

V. V. Lopatin and V. R. Borovskii. *Protsessy Perenosa Tepl. i Veshchestva*, 1985, 48 - 51; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R426.

Results are given of investigations into sugar losses during steam treatment of cossettes. It was found that treatment of a layer of cossettes 20 - 90 mm high and 4 - 10 mm thick for 2 - 10 min caused average losses of 1.2%. The results may be applied to estimation of the sugar losses in existing and planned industrial equipment.

Some methods for increasing raw juice purification

V. A. Loseva, I. S. Naumchenko and R. P. Lisitskaya. *Mater. Mezhresp. Nauch.-Tekh. Konf. Mol. Uchenykh po Sostoyan. i Perspekt. Malo- i Bezotkhod. Tekh. i Ispol'z. Vtor. Mat. Resursov*, 1985, 27 - 29; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R428.

A number of methods have been developed for pretreatment of raw juice, aimed at greater coagulation and colloid removal so as to raise the degree of purification and increase sugar yield. A reduction in pH to the isoelectric point, treatment with salts (ammonium sulphate, sodium sulphate and sodium sulphite) and treatment with live steam are included. After precoagulation by these methods, precarbonatation with a small amount of lime was carried out with simultaneous gassing and flocculation with polyacrylamide. The methods permitted a rise in the purification efficiency, increase in the purity of 2nd carbonatation juice, better quality of the resultant syrups and a 0.1 - 0.5% rise in sugar yield.

Development of a two-massecuite scheme for *A*-massecuite crystallization from high-purity syrup

A. I. Gromkovskii, V. F. Dobromirova and N. F. Kolomiets. *Rpt. Voronezh Technol. Inst.*, 1985, 11 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R430.

The possibility was investigated of using the advantages inherent in 3-massecuite boiling to develop a 2-massecuite scheme including two-stage treatment of *A*-massecuite by pan boiling and cooling. The crystallization rates in impure solutions were determined using molasses from Ramon sugar factory, a boiling house balance was calculated and a scheme developed for *A*-massecuite crystallization from syrup of 91.5 purity.

Obtaining highly concentrated remelt liquors in a bladed-mixer vessel

A. I. Gromkovskii, N. P. Mazaev and V. V. Moskalenko. *Rpt. Voronezh Technol. Inst.*, 1985, 11 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R431.

The feasibility of obtaining highly concentrated remelt liquors in a model vessel provided with a bladed stirrer was investigated with model sugar solutions as well as consumption sugar, *B*-sugar and low-grade affined sugar; experimental conditions were a solvent Brix of 15 - 65°, a final Brix of 65 - 75° and a temperature of 30 - 80°C. The size of the crystals of the initial sugar was assumed to be constant at a crystal content of 10 - 50%. The experimental data were analysed using a theoretical mass transfer equation, and equations were derived for laminar and turbulent mixing.

Some methods for reducing the sugar content in molasses

V. I. Smagina, V. S. Shterman and A. R. Sapronov. *Mater. Mezhresp. Nauch.-Tekh. Konf. Mol. Uchenykh po Sostoyan. i Perspekt. Malo- i Bezotkhod. Tekh. i Ispol'z. Vtor. Mat. Resursov*, 1985, 114 - 115; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R434.

The effect of $MgSO_4$ on beet molasses exhaustion and viscosity at different temperatures was investigated, 0.5 - 1.0% of the sulphate on weight of low-grade massecuite being added in the crystallizer. The molasses standard purity fell by 1.5 - 3.5%, low-grade sugar yield rose, and an extra 2.0 - 2.2 tonnes of crystal sugar could be obtained.

Vapour recompression: a novel solution at Guignicourt sugar factory

Anon. *Sucr. Franç.*, 1986, **103**, 103 - 104 (*French*).

So as to increase evaporation, a Kestner falling-film evaporator and a compressor were installed in parallel with the multiple-effect evaporator; the Kestner unit uses 1st effect vapour and has an hourly evaporation rate of 82 tonnes (although rates have varied from 15 to 80 tonnes/hr) at an effective temperature difference of 6.8°C. The system can be stopped and started very easily. No colour formation has been found in the juice, and less than 2 ppm of sugar has been detected in the condensate.

Laboratory studies

Chromatographic separation of molasses using the leading electrolyte method

R. F. Kambarova, N. B. Kazakova and G. A. Chikin. *Sakhar. Prom.*, 1986, (3), 24 - 27 (*Russian*).

The leading electrolyte method of chromatographic separation, in which water is the eluent, has the advantage of requiring only one type of adsorbent (cation or anion exchange resin) in the form of the ion to be separated, and is thus basically a reagentless method. KU-2 sulphonated cation exchangers in Na^+ form and containing 2 - 8% divinyl benzene were used in initial laboratory experiments on fractionation of model sugar solutions containing 40% sucrose and 3% sodium chloride; results showed KU-2-4 (containing 4% DVB) to be the best resin of those studied and 7 - 10% on resin volume to be the best load (out of a range of 3 - 30%). Subsequent laboratory tests were then conducted on sugar separation from delimed molasses of 35 - 40% dry solids. Because of overlap of the eluates, the concentration of the sucrose-rich fraction corresponding to the maximum on the elution curve fell as a result of dilution, from 9% to 5%. To prevent this, recirculation of the eluates was tried by a continuous and a semi-continuous method. While both methods recovered 40% of the initial sugar in the molasses and yielded a final fraction of approx. 10% concentration, a colour content of 130 - 160°St/100°Bx and a purity of 93 - 95 (which was 12 - 14 units higher than without recirculation), the continuous system treated more molasses per m^3 of resin per day. The composition of the recovered sugar fraction was comparable to that of 2nd carbonatation juice and could be mixed with it for further processing.

Influence of low-frequency mechanical vibrations on the rheological properties of low-purity massecuites

P. V. Pérez, I. Díaz and M. Juanes. *Zuckerind.*, 1986, **111**, 234 - 237.

The rheological behaviour of artificial low-grade massecuites was investigated using a laboratory system consisting of a rotary viscometer and a specially designed receptacle having as its bottom a membrane vibrating at a fixed magnitude of 1.2 mm and a frequency up to 50 Hz; the membrane is made to vibrate by means of an eccentric axis linked to a rod fixed to the membrane. Water was circulated through ducts in the walls of the receptacle at a controlled temperature. The massecuites were prepared from 86°Bx syrup of 45 purity with 0.42 - 0.59 mm refined sugar added to give crystal contents up to 50%. At 50, 55, 60 and 65°C the massecuites had a marked non-Newtonian character, with the results closely agreeing with the Ostwald de Weale model for pseudo-plastic fluids. Consistency fell with increase in the frequency of the vibrations and with rise in temperature; some overlapping of these effects occurred as a result of rupture of the internal structure of the liquid phase, so that at 50°C the vibrations caused a 56% fall in consistency, whereas a rise to 65°C caused a 78% fall, compared with only 12% caused by the vibrations. However, this was less obvious at higher crystal contents, when other factors also had effect. At frequencies above 20 Hz there was a tendency towards saturation.

The thermo-chemical properties of aqueous sugar solutions

V. M. Perelygin and V. G. Borisko. *Izv. Vuzov, Pishch. Tekh.*, 1985, (5), 20 - 24 (*Russian*).

Equations are presented for calculation of the partial molar enthalpies of water and sucrose in solutions at 20 - 95°C, and from these are calculated the molar enthalpy of a solution (which rises with temperature and sucrose concentration) and its heat capacity.

Chemistry at the service of the sugar factory

Anon. *Sucr. Franç.*, 1986, **103**, 106 - 107 (*French*).

A short account is given of the activities of IRIS, the French sugar industry research organization, in the field of chemistry: analyses and technical collaboration with sugar factories on the spot, and research. Analytical work involves both routine analysis of products using standard methods and use of sophisticated methods such as various chromatographic techniques and atomic absorption for much more precise analyses. Examples of research carried out recently concern the effects of mineral additives on beet pulp pressing, sulphitation and waste water treatment.

Molecular association in the system sucrose-electrolyte-water

L. G. Belostotsksii, A. E. Arkhipets, R. Ts. Mishchuk and L. P. Reva. *Izv. Vuzov, Pishch. Tekh.*, 1986, (1), 39 42 (*Russian*).

The effect of sucrose on the activity coefficients of a number of ions was studied by potentiometry using ion-selective electrodes. The electrolyte concentrations were varied from 10^{-4} to 5×10^{-2} gram-ions/litre and the sucrose concentration from 0 to 1.9 moles/litre. The Debye-Hückel equation was used to calculate the small correction to apply to the activity coefficient of each ion in an aqueous solution of the same concentration as the sucrose solution so as to allow for the fall in dielectric permeability caused by the sucrose. Results for Ca^{++}, H_3O^+, K^+ and NO_3^- showed that sucrose caused a considerable increase in the activity coefficients of the cations and a slight fall in that of the anion, the effect on the cations being greater the stronger was the hydration. The increase in the Ca^{++} coefficient with rise in sucrose concentration suggests the reason for the precipitation of lime salts (of poor solubility) during evaporation, while the differing effect of sucrose on cations and anions is used as a basis for a hypothesis on the proton donor role of the hydroxyl groups in sucrose in relation to hydrogen bond formation between sucrose and water.

By-products

Improved glycerol production from cane molasses by the sulphite process with vacuum or continuous carbon dioxide sparging during fermentation

G. P. Kalle, S. C. Naik and B. Z. Lashkari. *J. Ferment.Technol.* (Osaka), 1985, **63,** (3), 231 - 237; through *S.I.A.*, 1986, **48,** Abs. 86-540.

Modifications to a conventional sulphite process for production of glycerol from cane molasses by means of *Saccharomyces cerevisiae* var. Hansen are described. Glycerol concentrations up to 230 g/litre and productivity of 15 g/litre/day were obtained by fermenting under vacuum (80 mm Hg) or with continuous sparging of CO_2 at 0.4 vol/vol/min. Under these conditions, sulphite consumption could be decreased by two-thirds to 20 g/litre, and the ability of yeast cells to ferment was maintained throughout 20 days' fermentation. For a given medium, there was an optimal molar ratio of sulphite to glucose consumed, which gave maximum glycerol yield; for cane molasses this ratio was 0.67.

Continuous fed-batch vacuum fermentation system for glycerol from molasses by the sulphite process

G. P. Kalle and S. C. Naik. *J. Ferment. Technol.* (Osaka), 1985, **63,** (4), 411 - 414; through *S.I.A.*, 1986, **48,** Abs. 86 - 541.

A continuous fed-batch vacuum fermentation system for the production of glycerol from cane molasses or juice by a conventional sulphite process is described. A glycerol concentration of 80 g/litre was achieved with a productivity of 30 g/litre/day at a dilution rate of 0.4/day. This productivity was twice that from a vacuum batch process, and four times that obtained without vacuum.

The case for a cane sugar–starch–paper complex

J. H. Gehlawat. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, G.23 - G.28.

The author proposes the construction of a complex that would include a sugar factory, a plant for the manufacture of starch, oil, etc., from maize grown as an intercrop with cane, and a paper mill that would use bagasse as raw material. A distillery integral to the sugar factory is also suggested. Surplus bagasse could be either processed in a pulping plant or used to generate surplus electricity. Other by-product installations could also be incorporated.

Heat pumps for energy saving in ethanol distillation

S. Gopichand and V. S. Patwardhan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, G.41 - G.51.

The principle of heat pump operation is explained and the possible energy benefits are indicated, particularly in alcohol distillation.

Characteristics of a variant strain of distillers' yeast

H. Shukla, R. Kar and L. Viswanathan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, G.53 - G.60.

A variant strain of *Saccharomyces cerevisiae* isolated from a culture of distillers' yeast was found to ferment cane molasses, juice and syrup to a greater extent than the parent strain, yielding at least twice as much alcohol and proving much more tolerant to higher fermentation temperatures (30, 35 and 40°C) and to higher initial sugar concentrations in the molasses medium.

Ethanol production from unclarified molasses. II. Stability of yeast strain HAU-1 and the effect of pitching rate on fermentation time

D. S. Dahiya, S. S. Dhamija and P. Tauro. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, G.61 - G.65.

The alcohol-producing performance of *Saccharomyces cerevisiae* strain HAU-1 in the repeated sedimentation recycling technique was examined over 20 cycles in which the strain proved stable, consistently yielding 8.2% ethanol (v/v) within 24 hours. The optimum concentration of yeast biomass for reduction in the fermentation time was 30 g/litre, at which fermentation was complete within 8 hours.

Effect of COD loads on the performance of ammonifying bacteria

S. Kumar and L. Viswanathan. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, G.67 - G.73.

The time pattern of the growth of four anaerobic bacterial cultures and of COD reduction by them were investigated at initial COD loads in the range 5000 - 40,000 mg/litre. Results showed that the growth of the bacteria occurred in two phases: in the first, they utilized certain compounds preferentially, after which there was an interval during which enzymes were synthesized for use in the second phase. These results suggest the possibility of developing a two-stage continuous fermentation process without any time lag between the two phases.

Integrated steam, power and other services for the paper-sugar complex at Mysore Paper Mills

K. S. R. Rao and T. Rajamohan. *Bharatiya Sugar*, 1986, **11,** (4), 23 - 26.

Details are given of the steam generating plant, turbine and alternators at the complex and of the steam and power balance when both sugar and paper are being produced and when only the paper mill is in operation.

Steam-heated pulp drying

Anon. *Zuckerind.*, 1986, **111,** 357 358 (*German*).

A steam-heated beet pulp dryer developed by BMA at the suggestion of Süddeutsche Zucker-AG is described. It consists of a horizontal, cylindrical pressure tank containing three perforated endless metal belts, one above the other, which carry the pulp while steam passes through it at right angles. Results from one campaign at Gross-Gerau factory included a final pulp solids content of 96 - 97% and the suitability of the dryer for treatment of wet pulp, even where molasses was added, was demonstrated.

Ethanol manufacture from sugar beet

Meinhold and E. Reinefeld. *Die Zuckerrübe*, 1986, **35**, 134 (*German*).

The economics are compared of two schemes for ethanol manufacture. The first scheme is intended for a sugar factory slicing 6000 tonnes of beet per day to produce white sugar; the run-off is stored and processed to ethanol after the beet campaign. The vinasse is concentrated to 50% dry solids and, in the following campaign, is dried together with surplus yeast on beet pulp. In the second scheme, both white sugar and low-grade sugar are produced at a factory slicing 15,000 tonnes of beet per day; the low-grade sugar is stored and processed to ethanol after the campaign. Both vinasse and molasses occur as waste products; the former is treated to yield biogas, which makes up half of the energy requirements of the alcohol fermentation process, while the molasses is combined with surplus yeast and pulp. Despite the much greater beet slice, the amount of ethanol produced annually under this scheme would be only 25% greater than in the first scheme, although the costs of alcohol manufacture relative to those of white sugar manufacture would be lower.

Optimization of the production of single-cell protein by *Saccharomyces uvarum* Y-1347 from beet molasses

A. M. H. El-Refair, K. M. Ghanem and M. El-Gazaeriy. *Chem. Mikrobiol. Technol. Lebensm.*, 1985, **9**, (4), 105 - 112; through *Ref. Zhurn., AN SSSR* (*Khim.*), 1986, (8), Abs. 8 R25.

In a survey of methods for production of single-cell protein (SCP) from various raw materials, the superiority of *S. uvarum* Y-1347 is shown, and results are given of laboratory investigations on optimization of processes for SCP production from beet molasses using this yeast. The optimum SCP yield was obtained with four days' cultivation on a substrate of pH 7 containing 70 g/litre clarified molasses, 7 g/litre $(NH_4)_2SO_4$ and 1 g/litre each of K_2HPO_4 and $MgSO_4,7H_2O$ at a mixing speed of 250 rpm and a C:N ratio of 17:1. The addition of corn extract increased yeast yield. The yeasts obtained contained 51.2% raw protein (N × 6.25) on dry matter (including 9.7% non-protein N), 20 - 32% carbohydrates, 0.16% nucleic acids, 7.0% lipids, 3.06% sterols, 2.72% ergosterols and 6.54% ash. Preparation of the yeast seed cultures is described, and the effects on yeast and SCP yield of the molasses and ammonium sulphate concentrations and of the sources of N and various organic and inorganic nutrients are indicated. The contents of 18 amino-acids in the yeast are compared with those in other yeasts.

Use of condensate from spent wash evaporation plant

P. L. Kulkarni and C. L. N. Raju. *Bharatiya Sugar*, 1986, **11**, (5), 19 - 20.

While vinasse concentration and incineration permit total elimination of pollution, concentration in evaporators produces large quantities of condensate of which only that from the 1st effect is suitable as boiler feed water, whereas the remainder from the other effects is of too low a pH (2.75 - 2.90) for this purpose. However, investigations of the possibility of using it to dilute molasses showed that it did not adversely affect fermentation, although it would have to be cooled before use.

Investigation of inhibitors obtained by chemical hydrolysis of sugar cane waste products

M. del C. Espinosa, C. Ramos and R. López. *Rev. Cienc. Biol.*, 1984, **15**, (2), 353 - 360; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (10), Abs. 10 R525.

Chemical hydrolysis of plant materials causes the formation, together with monosaccharides, of furfural, hydroxymethyl furfural, lignin and derivatives of humic acid, and organic acids which suppress the growth of yeasts. Some of the compounds mentioned were determined when bagasse was hydrolysed in the presence of H_2SO_4 and their effects on the fermentation process examined by fractionation of the prehydrolysate with active carbon and subsequent washing of the fractions with distilled water, ethanol and 0.1N NaOH. Qualitative and quantitative analysis of the fractions was carried out by gravimetric, photo-colorimetric, infrared and ultraviolet spectrophotometric methods. It was established that the fraction containing lignin derivatives had the greatest retarding effect on yeast growth.

Fructose manufacture from sucrose

N. A. Arkhipovich *et al. Sakhar. Prom.*, 1986, (5), 55 - 57 (*Ruissian*).

In a process tested at a refinery, 14% crystal fructose, 15% crystal glucose and 65% glucose/fructose syrup by weight of sucrose are obtainable, or (in a variant of it) the yields may be 22%, 18% and 54%, respectively. A 20°Bx refined sugar solution is acid-hydrolysed at 100°C for 6 minutes, the hydrolysate cooled to 0 - 1°C in two stages and limed. The resultant calcium fructosate is filtered off, diluted and gassed to pH 9.0 - 9.2, filtered, passed through ion exchange resin to remove the Ca^{++} and treated with active carbon; it is concentrated in two stages to 87 - 90% dry solids (with carbon treatment in between), filtered at a purity of 91 - 93, cooled to 55°C, crystallized by cooling, centrifuged, and the crystals washed, sieved and dried. The glucose solution from which the Ca fructosate has been separated is subjected to the same treatment as the fructose solution. The fructose and glucose molasses are mixed together, treated with active carbon and concentrated to 65 - 70% dry solids to yield a low-colour syrup containing 40 - 45% fructose and 55 - 60% glucose.

Patents

UNITED STATES

Glutamic acid production

T. Nakanishi, M. Kohata and M. Sakurai, *assrs.* Kyowa Hakko Kogyo Co. Ltd. **4,440,856.** December 16, 1981; April 3, 1984.

L-Glutamic acid is produced by cultivating a mutant micro-organism of the *Corynebacterium* or *Brevibacterium* genus (*C. glutamicum* or *B. lacto-fermentum*) on a carbon-containing medium such as sucrose, fructose, glucose, starch hydrolysate or molasses at 23 - 42°C (28 - 34°C) (34 - 42°C) and pH 6 - 9 for 24 - 72 hours.

Isoleucine production by fermentation

T. Tsuchida, K. Miwa and S. Nakamori, *assrs.* Ajinomoto Co. Inc. **4,442,208.** June 25, 1982; April 10, 1984.

L-Isoleucine is produced by aerobic cultivation of a *Corynebacterium glutamicum* or *Brevibacterium lactofermentum* micro-organism on a carbon-containing substrate such as glucose, sucrose, molasses or starch hydrolysate at 31°C and pH 7.2 for 72 hours.

Alcohol production

R. M. Dessau and W. O. Haag, *assrs.* Mobil Oil Corporation. **4,442,210.** September 2, 1981; April 10, 1984.

Anhydrous alcohol produced by fermentation of e.g. diluted molasses, sucrose, glucose or fructose is recovered from the mixture by adsorption on a crystalline zeolite having a silica:alumina molar ratio of at least 35:1 (at least 200:1), an effective pore diameter of at least 5Å and a crystal density in the dry H^+ form of not less than 1.6 g/cm². Adsorption takes place at 0 - 200°C and may be conducted during the fermentation so as to maintain the ethanol concentration at approximately 1% by volume below that which is toxic to the fermenting organism. A total of at least 14% (30%) alcohol by volume is obtainable by the method.

Fructose separation from glucose

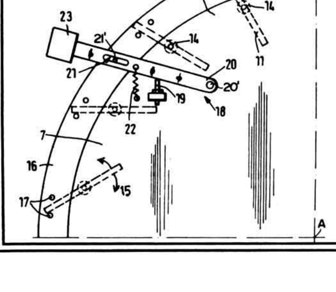
R. W. Neuzil and J. W. Priegnitz, *assrs.* UOP Inc. **4,442,285.** May 4, 1982; April 10, 1984.

Separation of the two monosaccharides in a mixture is effected by adsorption on an X zeolite containing K^+ ions at the exchangeable cationic sites, at 20 - 200°C (20 - 100°C) and a pressure in the range from atmospheric to 500 psig (atmospheric to 250 psig).

Continuous centrifugal

H. Schaper and H. Kurland, *assrs.* Braunschweigische Maschinenbauanstalt AG. **4,443,266.** July 15, 1982; April 17, 1984.

In a continuous centrifugal 1 having a conical basket 3, a rotary ring (or solid disc) 7 is located above the basket and is supported in a bearing 8 secured to cover 9 of the sugar collecting housing 6; a brake mechanism 10 acts on the ring. Spring-like members 11 of sheet metal of the order of 0.5 mm thick, attached to ring 7, reach into the flight path of the sugar crystals and are elastically deflected when struck by the crystals, being rotatable about their own axes 14. The amplitude of deflection is governed by the distance between the point of impact and the point at which the members 11 are attached to the ring, and increases



with the size of the spring. Vertical adjustment of bearing 8 makes it possible to vary the impact distance, while the angle of the members can be altered by means of ring 16 which carries stops 17 and to which is connected adjustment device 18, consisting of a lever arm 20. An adjustment screw 19 is located between lever 20 and ring 7 to allow adjustment against the action of spring 22; the free end of the lever carries a weight 23. Once adjustment of the members 11 has been effected by means of screw 19, the stiffness of spring 22 and the position of the weight along the free end of lever 20 are so balanced relative to each other that the initial position of screw 19 varies with the speed of ring 7 under the influence of brake 10 or an eddy current brake. Since all the axes 14 extend in parallel with the axis A of the basket 3, each member moves in the direction of arrow 15 so as to provide the most favourable angular position relative to the flight path; at this optimum angle, the sandblasting effect of the crystals will clean the members and prevent incrustation with sugar.

Continuous separation of fructose and glucose

P. Pansolli, A. Barbaro, A. Maimone and M. Valdiserri, *assrs.* E.N.I. Ente Nazionale Idrocarburi. **4,443,267.** February 16, 1983; April 17, 1984.

Glucose is continuously isomerized with enzyme at 60°C and pH 7 to fructose at a conversion rate of 48%, and the syrup then fed to the bottom of a column in a 3-column system in which the fructose is separated by passage through anion exchange resin in sulphite form. By means of suitable recycling, a final fructose concentration of 93% is obtained. The collected glucose is supplemented with additional glucose until attaining a Brix of 50°, whereupon it is recycled to the isomerization column.

Continuous alcohol fermentation

P. L. Rogers and D. E. Tribe, *assrs.*

Unisearch Ltd. **4,443,544.** March 3, 1981; April 17, 1984.

Ethanol is produced from e.g. fructose, glucose or sucrose, by cultivation of *Zymomonas mobilis* at 20 - 50°C and pH 3.7 - 8 with continuous or periodical withdrawal of some of the culture medium and replacement of it with fresh medium; the cells of *Z. mobilis* and the ethanol in the withdrawn portion are recovered and the cells returned to the culture medium.

Alcohol production

M. E. D. Hillman, of Columbus, OH, USA, *assr.* Battelle Development Corporation. **4,443,637.** June 17, 1982; April 17, 1984.

Ethanol is produced from a carbohydrate such as fructose, glucose, sucrose, etc., contained in a mixture which also includes (as catalyst) an oxide, hydroxide or carbonate of an alkali metal or alkaline earth metal, water and 10 - 95% by weight of the water of an organic solvent of high polarity and low volatility and having a boiling point of at least 150°C (e.g. an alcohol, ether, tertiary amine, amino oxide, quaternary ammonium hydroxide or sulphoxide). The mixture is reacted at 250 - 400°C (286 - 315°C) (275 - 325°C).

Proline production

T. Nakanishi and H. Hagino, *assrs.* Kyowa Hakko Kogyo K.K. **4,444,885.** May 6, 1983; April 24, 1984.

L-Proline is produced by cultivation of a micro-organism belonging to the *Corynebacterium, Arthrobacter, Brevibacterium, Microbacterium* or *Saccharomyces* genus on a suitable carbon source (fructose, glucose, sucrose, starch hydrolysate or molasses, etc.) plus 3 - 105 g/litre L-glutamic acid or pyrrolidone carboxylic acid, a suitable N source (preferably ammonia) and a suitable inorganic compound such as potassium phosphate, Mg, Mn or Fe sulphide, NaCl, $CaCO_3$, etc. Fermentation takes place at 25 - 40°C and pH 6 - 9 for 24 - 120 hours.

Polydioxanone crystallization using sucrose as nucleating agent

E. Borysko, of Somerville, NJ, USA, *assr.* Ethicon Inc. **4,444,927.** September 13, 1982; April 24, 1984.

Shaped particles for medical/surgical uses may be produced from polydioxane polymer by heating a mixture of the polymer with a small amount (<1% by weight) of finely ground sucrose as nucleating agent.

Glucose isomerase preparation and use

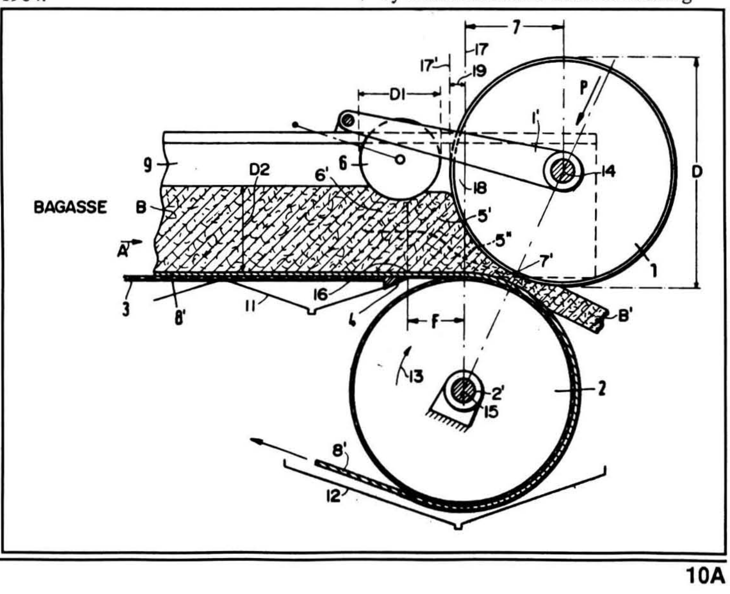
R. O. Horwath and R. M. Irbe, *assrs.* Nabisco Brands Inc. **4,447,531.** June 30, 1982; May 8, 1984.

Glucose isomerase is produced by cultivating a fungus of the Basidiomycetes class, e.g. *Mucronella aggregata* ATCC 20641, on a suitable medium which includes 5% by weight of xylose, and is then used to isomerize glucose to fructose at 60°C for 3 hours.

Bagasse dewatering

W. Kaether, of Braunschweig, Germany. **4,452,641.** July 13, 1983; June 5, 1984.

A conveyor belt 8' is supported by a stationary screen bottom 3 above liquid collecting troughs 11; the screen bottom has a non-perforated end member 4 with a smooth upward facing surface 16, and belt 8' is guided around a rotary screen drum or roller 2 below which is a liquid collecting trough 12. An open screenless section F is provided between the downstream end of member 4 and a vertical line 17. Bagasse from a diffuser is subjected to preliminary dewatering by passage under a compacting roller 6 which may be supported in a pendulum manner. It then passes between compression roller 1 and screen roller 2 which acts as a counter-roller. Roller 1 is supported by arms 1' which permit a rotational, pendulum movement. The spacing 7 between axis 14 of roller 1 and axis 15 of roller 2 is such that the bagasse blanket is bent downwards for a preliminary squeezing out, and forms a narrowing funnel shape as it proceeds further between the two rollers; hence, the bagasse is subjected to increasing compression as it passes from below compacting roller 6 and emerges on the other side of rollers 1 and 2. In tests conducted in a cane sugar factory, application of merely 2.4% of the normal pressure of 1000 kg/cm² applied by a conventional 3-roller dewatering



mill for about 40 seconds gave a residual moisture content of 48 - 50% compared with 50 - 51%.

Evaporator scale prevention

P. H. Ralston, S. L. Whitney and J. L. Walker, *assrs.* Calgon Corporation. **4,452,703.** May 24, 1983; June 5, 1984.

The formation of $CaHPO_4$ and $Ca(OH)_2$ scale in a sugar factory evaporator can be prevented by addition to the juice of 0.1 - 200 ppm (2 - 50 ppm) of polycarboxylic acid or its salt (polymalic acid of 200 - 40,000 molecular weight, an amine adduct of a maleic anhydride polymer, 4-phosphonobutane tricarboxylic acid, phosphinocarboxylic acid, or an acrylic acid copolymer such as sodium acrylate/hydroxypropyl acetate in a molar ratio of 30:1 - 1:3 and having a molecular weight of 500 - 500,000).

Threonine production

T. Tsuchida, K. Miwa and S. Nakamori, *assrs.* Ajinomoto Co. Inc. **4,452,890.** May 10, 1982; June 5, 1984.

L-Threonine is produced by aerobic cultivation of a micro-organism from the *Brevibacterium* or *Corynebacterium* genus (*B. lactofermentum* or *C. glutamicum*) on an aqueous medium such as a solution of sucrose, glucose, molasses or starch hydrolysate at 37°C for 72 hours.

Fructose separation from glucose

A. Miyahara, S. Sakai, F. Matsuda, H. Ushikubo and K. Kawano, *assrs.* Japan Organo Co. Ltd. **4,472,203.** July 19, 1982; September 18, 1984.

Fructose is separated from glucose in an aqueous mixture of the two sugars by passage at least twice through a fixed bed of cation exchange resin of the alkaline earth metal type in Ca^{++} form, so that a dilute glucose fraction, a glucose-rich fraction, a mixed glucose-fructose fraction, a fructose-rich fraction and a dilute fructose fraction are obtained after elution with water. The effluents are then recirculated to appropriate tanks in the order of separation and the process repeated at least twice until a fructose fraction of 91.5% concentration and a glucose fraction of 90.2% concentration are obtained..

Bagasse pulping

I. Wada, J. Ikido and W. Koido, of Tokyo, Japan, *assrs.* Oji Paper Co. Ltd. **4,473,439.** August 23, 1982; September 25, 1984.

Bagasse is delignified at 140 - 190°C with a cooking liquor containing sodium sulphide, NaOH, an additive consisting of at least one cyclic organic compound (a quinone, a hydroquinone, 9,10-diketohydroanthracene or 9,10-dihydroxyhydroanthracene) at 0.01 - 5% by weight of bone-dry bagasse, and a reducing agent such as a hydrogen sulphite or thiosulphate or sodium or potassium formate at 0.25 - 5% (0.49 - 5%) as Na_2O on weight of bone-dry bagasse; the effective alkali content is 8 - 40% and the sulphidity 3 - 50% on bone-dry bagasse.

Sucrose recovery from thick juice

S. Kulprathipanja, R. W. Neuzil and A. M. Landis, *assrs.* UOP Inc. **4,475,954.** April 15, 1983; October 9, 1984.

Sucrose may be separated from e.g. raffinose, KCl and betaine in beet thick juice and recovered from cane evaporator syrup by treatment with an adsorbent, which is a Y group zeolite in Na^+ form (possibly with alkali metals and alkaline earth metals at the exchangeable cationic sites) at 20 - 200°C (preferably 20 - 100°C) and a pressure in the range from atmospheric to 500 psig (from atmospheric to 250 psig). The adsorbent is preferably bound with a water-permeable organic polymer such as cellulose acetate. The sucrose is desorbed by elution with e.g. a 10 - 40% aqueous solution by volume of an alcohol containing not more than 4 carbon atoms per molecule.

Cane syrup or molasses treatment

S. Nakasone, S. Miyagi, T. Aragaki and Y. Higa, *assrs.* Daiichi Seito K.K. and Taito K.K. **4,492,601.** October 15, 1982; January 8, 1985.

As a pretreatment before electrodialysis by the transport depletion method, the pH of raw cane syrup or molasses is adjusted to between 6.5 and 7.5 with milk-of-lime and a water-soluble chloride of an alkaline earth metal such as calcium, barium or strontium added (followed by heating to 70°C) in order to precipitate inorganic anions such as silicate, sulphite and phosphate; the Brix is maintained at 60 - 80° during the reaction, but is reduced to below 55° by dilution after precipitation, followed by transport depletion using cation exchange film and neutral film, arranged alternately. Before electrodialysis, the pretreated solution may also be heated and treated with an additional amount of a chloride to precipitate any residual impurities; the solution may also be treated with a finely divided adsorbent for separation of further residual organic impurities.

which is loaded with pallets returned from customers, the pallets being taken from the incoming magazine and rotated so that an operator can see all round the pallet, top and bottom, and key in whether the pallet is sound or damaged (broken stringers, protruding nails, etc.) The pallet then transfers to a weighing station where overweight indicates a take-up in moisture. The pallet then goes to one of three magazines – Good/Dry; Good/Wet; Damaged.

From each Hesser machine, a vacuum system takes the clippings from the tops of packets to central automatic paper baling machine. There is a central vacuum cleaning system with the piping covering all the sugar handling and packaging areas, a fully equipped engineering workshop and engineering/spares stores. Adjacent to the packaging machine floor, there is the quality assurance centre and the packet weight data collection computer.

The effect

The Bury Packaging Complex is large. It was designed to give ample room for all equipment and this is very evident on the packaging machine floor which, like the rest of the building, can be kept clean and uncluttered. All equipment is fully automatic with either sequence control for the sugar feed or p.l.c. control for the packaging functions.

The only routine manual work is the provision of packaging materials – reels of packet paper and parcel paper, adhesives, sheets of paper for pallet covering and interleaving and polyethylene film for stretch-wrapping – all of which come in bulk quantities to keep machines and plant running for hours.

In theory, with full reels of paper on every machine, glue pots full and magazines of sheeted paper for the palletizers, the whole plant from bulk sugar in the 500-tonne silo through to palletized sugar in the warehouse racking would run, completely unattended, for $2^1/_2$ hours and produce 132 tonnes from the eight machines. Then new paper reels would have to be put on the Hesser machines.

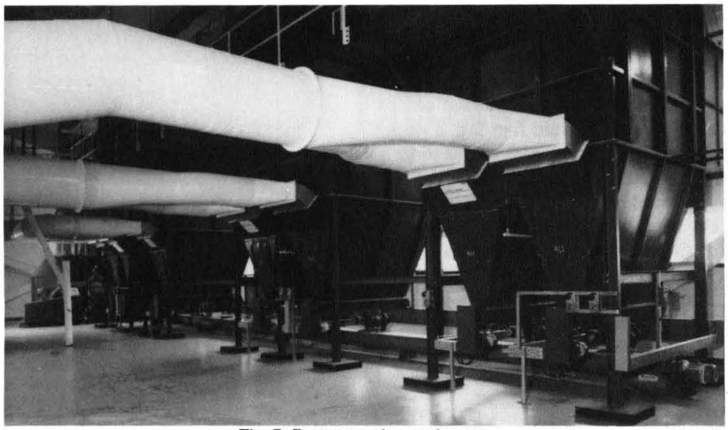


Fig. 7. Dust extraction equipment

Comissioning and running

There were no major snags during the comissioning of all plant, no major design faults requiring plant modifications, but a few minor teething problems to be expected in a plant of this size and complexity. Such teething problems included the necessity to fit hot melt glue applicators to apply a non-setting glue to parcels into the parcel palletizers to stabilize the load through the warehouse and into distribution, and included ironing the bugs out of the warehouse computer software.

The major problem, when the plant went into production, was the staffing, at all levels, with inexperienced people as regards the running of packaging equipment. Any stoppage, even to change a paper reel, was protracted; machine adjustments were often made in the wrong direction and breakdowns took a long time to correct, all because virtually no-one had any experience in running Hesser packers, parcellers and palletizers. In September 1982, the staff were right at the bottom of a long, slow learning curve and, owing to pressures on production at other Hesser plants (Newark and York), only a limited amount of experienced help was available.

Maintenance was on an *ad hoc* basis and production had to be checked constantly for quality.

It took until the autumn of 1983 before the learning curve had been climbed; maintenance was planned on a preventive basis with work schedules being generated by computer, production was up to the planned 4000 tonnes/week and quality was assured.

Although eight Hesser lines are installed, the required production comes from any seven machines with the eighth machine available for routine overhaul and maintenance. Production is based on a 5 day/3 × 39 hour shift/week basis and includes breaks for cleaning the machines each day. Production in excess of 4400 tonnes has been achieved in a week.

The Packaging Complex is completely self-contained to include all operating and adminstration personnel, a total, including all shift workers and office personnel, of 100 people. Many staff have had to adopt multi-discipline roles. The packeting plants which had been closed down employed in excess of 300 people in total. Considerable savings have also been made in inter-factory sugar transport costs.

A great deal of work was involved in the design, building and commissioning of the Bury Packaging Complex and the finished cost for the whole complex was £18,600,000. The outcome is a successful and magnificient plant which impresses all visitors and which produces 40% of British Sugar's granulated packets and distributes these and special sugars over the UK market.

Upgrading batch centrifugal automatic controls*

By Leif Ramm-Schmidt and Ari Rintala
(Finnish Sugar Co. Ltd., Porkkala Refinery, Finland)

L. Ramm-Schmidt

A. Rintala

Introduction

The Finnish Sugar refinery in Porkkala was started in 1965. The capacity of the plant is 700 tonnes per day of melt, and it runs five days a week on a three-shift basis. All the affination, *A*-grade and white sugar centrifugals are ASEA-made 48-inch 600 kg DC-driven fully automatic batch centrifugals. The centrifugals were manufactured in 1964 - 1965 and the original relay-based automatic controls are also more than 20 years old. The batch centrifugals are 12 in number, while additionally there are four continuous BMA-centrifugals for *B*- and *C*-massecuites.

Since we have speeded up the boiling operation the white sugar centrifugals have become the bottleneck of the refinery operation. Thus, it is of great concern that the centrifugals operate with a minimum of downtime.

In 1983 we decided to install a new distributed digital process automation system called Damatic, made by Valmet. The system should, over a period of four to five years, replace all old process controls. Most of these controls are of the pneumatic type. The decision was also made to renew the centrifugal control system; however, the way to do so was not decided.

Problems with the present automatic controls

The automatic control of batch centrifugals, with all sequences and different security interlocks, forms a very complex system. The number of relays, timers and on-off switches is enormous. We counted them in our centrifugals and found altogether 41 relays, 9 time relays and 10 limit switches for each centrifugal.

When relays and mechanical switches get older the risk of malfunction increases. Our maintenance department records all electrical faults which have needed an electrician outside office time. Almost two-thirds of these malfunctions are related to the batch centrifugals. The total number of malfunctions for the whole battery is approximately 180 per year or three to four faults every week. The distribution of electrical faults in the main process steps is shown in Figure 1. (Note: the actual numbers are about 50% higher). The time needed to find a fault in the centrifugal automatics is often very long because of the complex interlocking systems. A certain number of undefined "phantom" faults has also been noticed. Furthermore, as our electricians are only on duty outside office time, this increases the downtime of each incident.

A complete renewal of all relays decreased the total number of malfunctions by only 10 - 20% since there were still faults in all the other electrical equipment. Figure 2 shows the distribution of electrical faults in the centrifugal station.

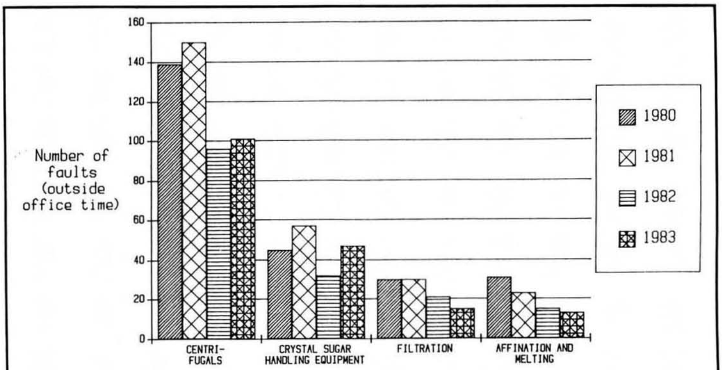


Figure 1

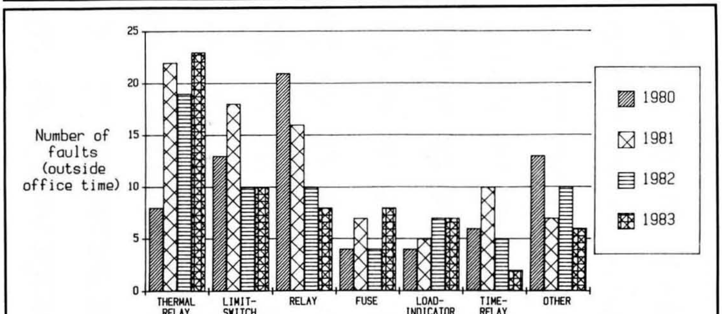


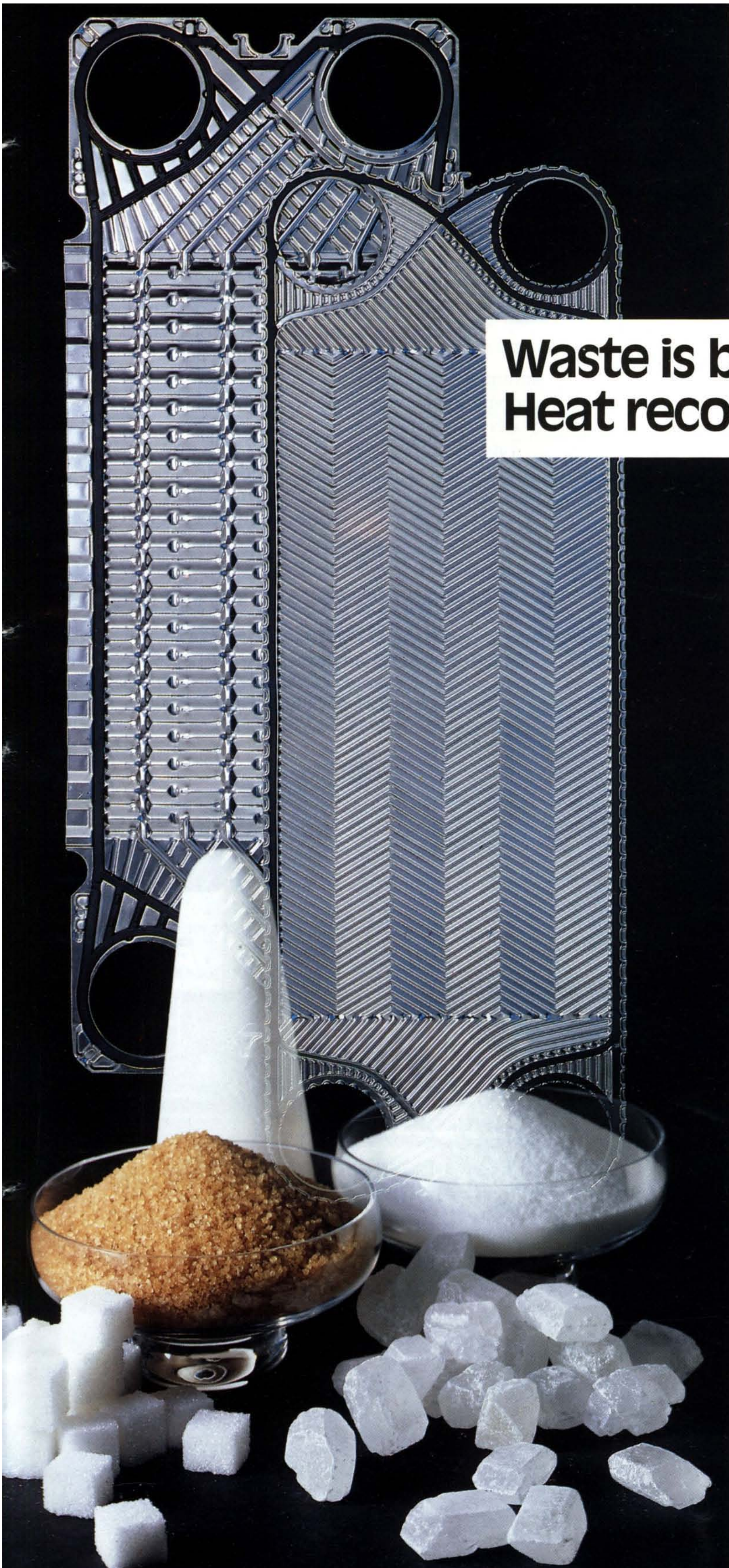
Figure 2

Reasons for upgrading

There are two major reasons for upgrading centrifugals; either to obtain a higher capacity or else to decrease production costs. A significantly higher capacity could certainly be achieved by buying a larger machine but an improvement in operation reliability would also have a beneficial effect on the capacity. Lower production costs can be obtained by reducing energy usage, reducing maintenance and by improving flexibility in the setting of process parameters.

The centrifugal station represents, in the authors' opinion, the most important step in the process, since the total refinery throughput passes twice

* *Paper presented to the 45th Ann. Meeting Sugar Ind. Technol.*, 1986.

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through centrifugals, first in affination and secondly in the white sugar side. The affination is the basis for the whole recovery treatment. When fine tuning a refinery we believe that an inspection of the centrifugal station should be carried out first of all.

There are many things to do in the centrifugals. A total renewal of the automatic control system with use of modern electronics makes it easier to improve the yield. This results in a better matching of process parameters to the sugar being cured. A higher yield and a reduction in downtime also increases the plant capacity. In some cases this increase can be satisfactory and avoids the need to buy totally new machines.

After making some improvements to the wash water system, the decision was taken to renew the automatic control system totally.

Alternatives

The new control system should have the following main features:

(a) highly reliable operation in order to reduce downtime and to avoid accidents,

(b) easy parameter setting from the central control room,

(c) the possibility of recording and reporting centrifugal battery data in printed form, and

(d) a fault detecting system to reveal the nature and location of a malfunction.

Alternative systems considered included the following:

(1) A completely separate controlling system based on a common computer to control all batch centrifugals. A monitor with keyboard and printer should be placed in the central control room.

(2) The existing Damatic process control system could be used. Each centrifugal should be separately connected to the Damatic. The Damatic already includes a printer and a fault detecting system.

(3) Each centrifugal should be controlled by separate independent micro-computer-based programmable logics. The logics would be connected to the Damatic process control system. The existing printer could be used for recording.

The major advantages and disadvantages of the different systems are as follows:

(1) Similar systems have been in use in other refineries since the 1970's, so the technical solutions are certainly well known. But a new separate system would not match our existing system, e.g. in terms of maintenance and spares, etc. The system also needs extra space in the central control room for monitor and printer. A fault in the computer would mean that all centrifugals are down at the same time. A computer controlling the whole battery of centrifugals is slower than logics controlling only one centrifugal which could mean a loss of some seconds for each sequence. The computer has to be of a very fast type.

(2) Use of the Damatic would mean purchasing a minimum of new equipment. The programming and maintenance of the system is already well known to our people. A fault in the Damatic could, as in alternative 1, mean that all centrifugals are down at the same time.

(3) Separate logics for each centrifugal would add to the reliability because each system could work independently of the Damatic. Asea has recently equipped their centrifugals with such logics of their own design (Asea Master Piece PC). A fault detecting system is included. These logics, however, have no centralized parameter setting and recording device. Thus the right type of connexion to our Damatic system had to be developed.

Alternative 1 was discarded without any further investigation. Alternatives 2 and 3 were checked in more detail. A cost evaluation showed that alternative 3 was by far the cheapest. The Damatic process station time cycle could be too long for detecting short impulses from on-off switches (time cycle 0.4 sec). So we decided to test the system on one of our affination centrifugals.

The Asea Master Piece PC logics

The Asea logics system is developed especially for the control of DC-driven batch centrifugals. The diagram of Asea's standard system is shown in Figure 3.

The charging, centrifugalling and discharging speeds can be easily programmed in the PC and varied within wide limits to give the best purging of any type of massecuite for maximum production and minimum cost in kWh per tonne of sugar.

The current limits can also be easily varied, which enables the acceleration rate to be changed when badly boiled high-grade and low-grade massecuites are being cured.

The Master Piece, with all other electrical equipment, is easily installed in the two original cubicles. Because of the tremendous reduction in the size of relays the equipment is easily accessible to facilitate measurements and maintenance.

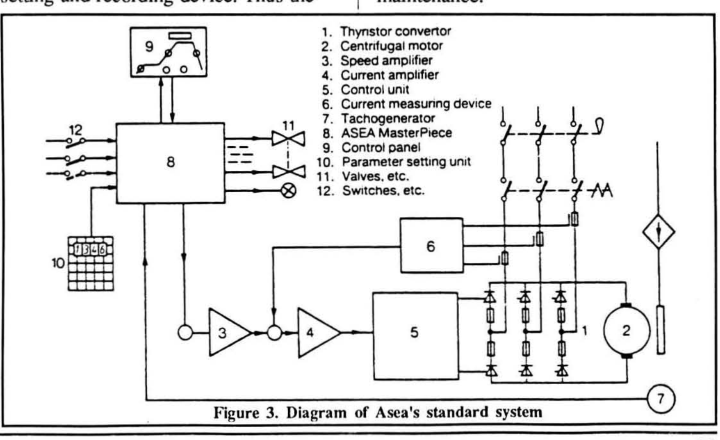


Figure 3. Diagram of Asea's standard system

The parameters which are to be adjusted during commissioning are set by using a special transportable programming unit (the Master Aid programming unit). Such parameters are:

Parameter	Normally set value
Speed, charging	250 rpm
Speed, discharging	60 rpm
Max. time, plough in working position	10 sec
Max. time, plough scraping	35 sec
Time, plough in lower working position	6 sec
Max. time, charging	2 times actual charging time

The parameters which are adjusted more often are in our case set from the Damatic instead of the parameter setting panel which as standard is installed in the front door of the cubicle.

The Master Piece includes a central fault indication system to which a great number of protections are connected.

In case of a fault a common signal lamp in the control panel is lit, a digital fault indication is given and an alarm horn sounds simultaneously. Individual lamps in the control cubicle also indicate which protection has initiated the alarm.

The following functions are controlled by the Master Piece and alarmed:

- Motor temperature
- Motor cooling air
- Air pressure for pneumatics
- Functions of converter
- Centrifugal speed
- Oscillations
- Total charging time
- Charging equipment
- Main gate
- Discharger in the upper position
- Discharger in the lower position
- Discharger to working position (max. time)
- Discharger going down (max. time)
- Discharger going up (max. time)
- Discharger to resting position (max. time)
- Discharger speed

The control panel (Figure 4), which is mounted on the centrifugal frame post, is used for manual operation. It contains a digital display for speed of rotation, motor current, main gate position and a digital fault indication.

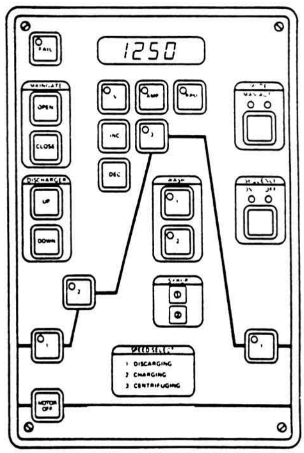


Figure 4. Control panel

Communication between logics and Damatic

A most reliable communication system between the logics and the Damatic had to be developed. We ended up using straight connexions instead of the data bus principle because this was more suitable for the Damatic and the easiest way to make it work. The reliability of a straight connexion is also better than that of the data bus which was certainly a more modern solution. But, on the other hand, to transform the data we desired, we need one main cable only seven wires of which are used per centrifugal or one wire for each item of data. Since each centrifugal cubicle with Master Piece PC as standard contains a parameter setting panel, the program of each of the logics already has provision to permit parameter setting from an outside source. Thus, the connexion to the Damatic was easily made. The following functions are set and controlled from the Damatic:

spinning time
starting and length of washes 1 and 2
screen wash and selection of interval (every cycle, every second cycle, every third cycle or no wash)

The magnitude of each parameter is given by one analogue signal of 4 - 20 mA. Each parameter is labelled by BCD coded binary outputs. Thus, it is possible to send four parameters using two binary codes. The 00-coded label, however, is not used for safety reasons.

The Damatic is programmed to have one display for each centrifugal. The display is divided into sections with the following functions:

Section 1: Wash 1 in litres and the feedback of the wash flowmeter
Section 2: Number of the wash (1 or 2). Hand operation of the wash valve and the wash tube air purge valve
Section 3: Wash 2 in litres and feedback of the wash flowmeter
Section 4: Time interval between washes 1 and 2
Section 5: Screen wash in litres and selection of interval
Section 6: Starting speed of wash 1 and spinning time

Each parameter value is easily set from the key board. The Damatic also records the number of cycles.

Total scope of upgrading

In upgrading centrifugals along with the control system the number of devices to be replaced depends very much on the age of the accessories in question. In our case the centrifugals were more than 20 years old. First the cumbersome DC-converter (RTMB/C) had to be replaced by a new thyristor converter of the silicon controlled type (YGMK). All limit switches were replaced using inductive proximity switches. A new oscillating detector based on a proximity switch was installed. Also all mg-valves for the pneumatic cylinders were renewed.

The main gate was modified so that the opening could be adjusted in five steps and controlled from the control panel.

The wash system had already been renewed earlier. We measure the amount of wash water volume instead of time. This gives a much more exact measurement, because it is not affected by pressure fluctuations in the supply line. Additionally we equipped the wash tube with air purging to avoid unnecessary dissolving of sugar in the lower end of the basket. The amount of water left in the tube is more than half a litre or altogether over one litre when two washes are used. As one litre of hot water dissolves about 3 kg of sugar the unnecessary loss is about 1%, representing more than 1000 tonnes of sugar overall per year in our centrifugals. (In a bigger centrifugal the relative loss is smaller). Additionally all extra wash water used has to be evaporated. When renewing the automatic control system it is easy to install an air purging system. (The air has to be filtered and oil-free to avoid black specks in the sugar!)

The scope of upgrading is shown in Figure 5.

Cost

The total cost for an upgrading of the magnitude presented above is about 20 to 25% of the price for a new machine, according to Asea. In our case the cost of the first unit was about US$28,000 which included programming and installation. The cost of subsequent units is $17,000 each because of lower programming costs.

Experience

So far the centrifugal has been in use since February 1986, without any faults. Our personnel are very satisfied with the layout and the technical solutions. We have also observed that the total cycle time has been shortened giving extra capacity.

Initially we had some problems with installation and starting-up. The control panel was not protected for field installation into the existing centrifugal frame post, so we had to design a suitable mounting box specifically for the purpose. On the first spinning of the machine the thyristors broke because of too big a field strength distributor. When this was changed from 10 amp to 5 amp the system worked all right.

Future plans

It has recently been decided to renew the rest of our batch centrifugal control systems as described above; installation of the next four systems will be done this year. When all centrifugal controls are renewed the report system will be developed. The Damatic makes it possible to adjust parameters for several centrifugals with only one command. This is very convenient when there is a battery of centrifugals doing the same job (e.g. affination).

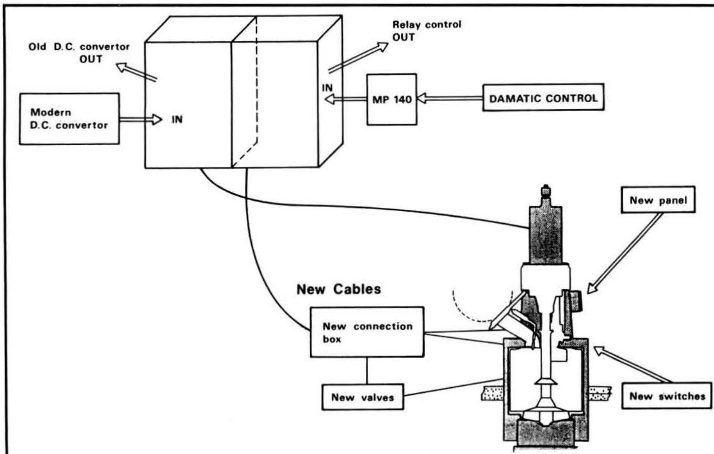


Figure 5. Layout of electrical retrofit

Conclusions

Rapid progress in electronics has made it possible to run and control the centrifugals — the most important step in the process — in a new, reliable and efficient way. The cost of upgrading is small compared with the benefits gained. Thus, the money invested has a short payback time.

Summary

The 12 ASEA-Weibull D.C.-driven batch centrifugals at the Finnish Sugar refinery in Porkkala are more than 20 years old. Over the years the number of shut-downs due to malfunctions in the automatic controls has increased significantly. This is especially serious, since the centrifugals in Porkkala are the bottleneck in the production. A reduction in faults had been achieved by renewing the whole battery of relays. However, the system is still very complex and needs a lot of maintenance. The decision was made to renew the total centrifugal control system using the Asea microcomputer based "Master Piece PC" logics with the parameter setting from existing Damatic process automation and report system already in use in Porkkala. At the same time all the mechanical on-off switches were renewed using inductive proximity switches. The mg-valves were also renewed as well as the D.C. rectifier system. The new equipment has been tested since February 1986 in one affination centrifugal with extremely good results; almost all malfunctions have disappeared. The paper deals with different alternatives to renew batch centrifugal automatic controls including a more detailed description of the system chosen. Cost figures for this system are also given. As the system is very flexible to operate, it is possible to run the centrifugals optimally in all cases, e.g. concerning wash water amount and timing for varying massecuites. This gives a realistic payback time for the money invested.

New Rumanian sugar factories[1]

The new sugar factory at Lechinta[2] in the Bistrita-Nasaud district has been put into production in addition to those at Calarasi, Fundulea and Racari, which have also gone into operation. Other factories in Oltenita, Liesti, Teius, Carei, Trusesi and Tarani are reported to be in advanced stage of construction. They are small units designed to process 1000 tonnes of beet per day and are built in areas where sugar beet is grown. The new factories which have been brought into operation bring the country's processing capacity up to about 75,000 tonnes/24 hours. When the other units are put into service (intended by the end of 1986) the daily capacity will have risen to more than 85,000 tonnes, double that of 1980.

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 617.
2 See *I.S.J.*, 1986, **88**, 100.

Molasses purity rise across continuous *C*-centrifugals

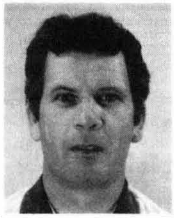
By L. M. S. A. Jullienne*
(Sugar Milling Research Institute, Durban, South Africa)

Introduction

The first continuous centrifugal was introduced in the South African industry in the late 1950's. Its many advantages were quickly recognised and by the mid-1970's this type of centrifugal had completely replaced its batch-type counterpart for curing of B- and C-massecuites. Over the years the industry has taken advantage of the better separation characteristics of the continuous centrifugal to produce *C*-massecuites of high Brix, low purity and smaller crystal size. This has undoubtedly contributed greatly towards the improvement in final molasses exhaustion which has taken place in the industry over the past twenty years. It must be pointed out, however, that in most mills major improvements to the vacuum pan and crystallizer stations had to be carried out to accommodate these more viscous massecuites, before the full potential of the continuous centrifugals could be realized.

Over the years, the design and operation of continuous centrifugals has been improved, largely through the contributions of many sugar technologists[1-7], both in South Africa and elsewhere. However, the relatively high rise in molasses purity which occurs across the centrifugals has remained a cause for concern. The exact cause of the purity rise has never been conclusively explained, a fact which is not entirely surprising when account is taken of the large number of variables involved in the operation of the centrifugal, and of the constantly changing characteristics of the massecuite under factory conditions.

In 1980 a new project was initiated at the Sugar Milling Research Institute to determine the optimum conditions for the operation of continuous centrifugals, with special emphasis on the molasses purity rise across the machine. The project, which started out using a statistical approach, eventually covered a period of four seasons, the effort over the last two seasons being mostly directed towards the measurement of the crystal size distribution of *C*-massecuite and its


L. M. S. A. Jullienne

effect on the molasses purity rise.

The findings of the project[8,9] are reviewed and summarized in this paper.

Experimental procedure

The project was divided into two main areas of investigations:–
(a) the effect of the operational variables
(b) the effect of the crystal size distribution in the massecuite.

The operational variable investigation was started with a series of factorially-designed experiments followed by a number of comparative tests. The operational variables investigated were massecuite throughput, wash water-to-massecuite ratio, water temperature and steam addition, the dependent variables being molasses purity and *C*-sugar purity.

The range of values for the set variables was as follows:

Massecuite throughput: 800 - 2400 kg/hr
Wash water % massecuite: 4 - 20%
Water temperature: 50 - 80°C
Steam addition: nil to valve fully open.

All the tests were carried out on factory centrifugals, namely BMA K850 and Western States CC5 and CC6, at a number of mills, using *C*-massecuites as normally supplied to the centrifugal station. The characteristics of the *C*-massecuites tested were:–

Apparent purity: 47 - 56
Refractometric Brix: 91° - 96°
Temperature at curing: 58° - 63°C
Viscosities at curing: 500 - 2600 Pa.s.

All the tests were carried out with new screens having a nominal slot width of 0.06 mm. To ensure that there would be no major change in the massecuite characteristics during each series of tests, it was found necessary to complete every experiment within a period of six hours.

The crystal size distribution investigation was initiated as a result of the findings of the first investigation mentioned above[8]. Concurrently with the investigation, a monthly crystal size survey of *C*-massecuites in the industry was undertaken. The crystal size measurements were made on a Kontron MOP Videoplan, which is a semi-automatic computerized particle size analyser. This part of the investigation consisted in measuring the molasses purity rise at a centrifugal under normal operating conditions (ΔP_t) and under "dry run" conditions (ΔP_p) where the wash water and steam additions were shut off. The crystal size of each massecuite and "dry run" molasses were measured and the purity rise was measured relative to the purity of the molasses separated from the massecuite in a Nutsch pressure filter[10]. The "dry run" purity rise (ΔP_p) is a measure of the physical losses due to the passage of small crystals through the screen slots.

The operational loss (ΔP_o) caused by crystal dissolution by washing is equal to ΔP_t minus ΔP_p so that

$$\Delta P_t = \Delta P_p + \Delta P_o$$

Results and discussion

Factorial experiments

The data from the factorial experiments were subjected to a multi-linear regression analysis to obtain equations for *C*-sugar purity (U_s) in terms of the other operational variables. Some typical equations are given in Table I.

As shown by these equations, the wash water-to-massecuite ratio is the operational variable with the greatest influence on sugar and molasses purities. It was found that operational variables

* Present address: c/o Sugar Consultants International, P.O. Box 1246, Durban, South Africa 4000.

1 Carter: *Proc. S. African Sugar Tech. Assoc.*, 1970, **44**, 108 - 113.
2 de Robillard: *ibid.*, 1974, **48**, 24 - 33.
3 McEvoy & Archibald: *ibid.*, 1975, **49**, 80 - 85.
4 Kirby: *Proc. Queensland Soc. Sugar Cane Tech.*, 1971, **38**, 95 - 99.
5 Kirby & Stewart: *ibid.*, 1972, **39**, 217 - 222.
6 Kirby *et al.*: *ibid.*, 1976, **43**, 255 - 262.
7 Swindells & Ness: *Proc. Amer. Soc. Sugar Cane Tech.*, 1979, **46**, 217 - 221.
8 Jullienne: *Proc. S. African Sugar Tech. Assoc.*, 1982, **56**, 37 - 40.
9 Idem: *ibid.*, 1985, **59**, 79 - 82.
10 Munsamy: *ibid.*, 1980, **54**, 79 - 81.

Table I. Equations for *C*-molasses and *C*-sugar purities in terms of the other operational variables

Factory	C-molasses purity (U_f)	C-sugar purity (U_s)
3	$U_f = 35.2 + 0.13\ W_r$	$U_s = 74.3 + 1.01\ W_r - 0.005\ Q_m$
4	$= 32.3 + 0.12\ W_r + 0.01\ T_w$	$= 60.2 + 1.07\ W_r + 0.09\ T_w$
5	$= 35.7 + 0.29\ W_r$	$= 61.3 + 3.76\ W_r - 0.006\ Q_m$

W_r = water addition % massecuite
T_w = wash water temperature, °C
Q_m = massecuite throughput, kg/hr

which affected sugar purity also affected molasses purity in the same direction and, in general, a unit change in *C*-sugar purity was accompanied by approximately 0.1 change in *C*-molasses purity. This was confirmed by the strong correlation between the *C*-molasses and *C*-sugar purities found in all the tests, of which the equations given in Table II are typical. The data from one test are shown graphically in Figure 1.

All other parameters being kept constant, an increase in the massecuite throughput was generally found to result in a decrease in the sugar purity without an accompanying reduction in molasses purity.

The effect of the steam addition was found to be significant in only one test, which, however, should not be taken as an indication that it always has a negligible effect on the centrifugal performance. The non-significance of steam, in this instance, was probably due to the narrow range of steam addition used during the tests.

Comparative tests

These tests were carried out with the object of detecting more precisely any effect which might have been hidden in the more complex factorially designed experiments. The tests investigated directly and separately the effect of steam addition, wash water addition and temperature on the *C*-molasses purity and on centrifugal capacity. Each series of tests was carried out on the same centrifugal over a short period of time and at approximately the same *C*-sugar purity, in order to eliminate the effect this parameter has on molasses purity.

Table II. Regression eqations between *C*-massecuite purity (U_f) and *C*-sugar purity (U_s)

Factory	C-sugar purities	Regression equation	Significance
3	69 - 86	$U_f = 0.08\ U_s + 31.03$	99%
4	69 - 88	$= 0.10\ U_s + 26.57$	99%
5	70 - 88	$= 0.06\ U_s + 33.01$	99%

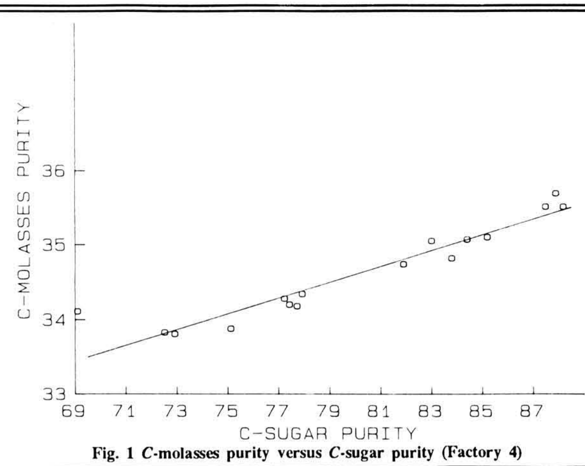


Fig. 1 *C*-molasses purity versus *C*-sugar purity (Factory 4)

(a) Steam addition

The effect of steam on the centrifugal performance was investigated at Factories No. 3 (18 tests) and No. 5 (10 tests). The tests were run by keeping the quantity and temperature of the wash water at their normal factory levels and changing the steam admission from a high to low level for every alternate run. The results for Factory No. 3 are shown in Table III.

As can be seen, the use of extra steam increased the capacity by 34% and 46%, accompanied by an increase in molasses purity of 0.64 and 0.40 for the two experiments. At Factory No. 5 there was a 20% increase in throughput and an average increase of 0.60 in the molasses purity.

(b) Wash water addition

A series of tests was carried out at Factories No. 4 and 5 with the wash water addition adjusted at two different levels at every alternate run. The wash water temperature and steam addition were kept at normal operating conditions. The performance results are summarized in Table IV.

In the tests the increases in capacity of 20% and 14%, respectively, obtained at higher water addition were accompanied by about 0.3 rise in final molasses purity.

(c) Wash water temperature

Thirty tests were carried out at Factories No. 3 and 4. The water and steam additions were adjusted at normal factory level and the water temperature changed from 80°C to 50°C for every alternate run. The results are summarized in Table V.

Table III. The effect of additional steam on centrifugal performance at factory 3 (each test is the average of 9 runs)

Test No.	Steam addition	Massecuite flow rate, kg/hr	C-sugar purity	Final molasses Temp., °C	Brix	Purity
1	Normal	1680	81.9	58.4	79.2	40.00
	High	2250	83.1	67.4	81.4	40.64
2	Normal	1800	79.4	61.1	81.0	38.90
	High	2620	80.5	68.0	83.5	39.30

Table IV. The effect of wash water addition on centrifugal performance (average of 8 tests at Factory 4 and 14 tests at Factory 5)

Factory	Water addition, kg/hr	Massecuite flow rate, kg/hr	C-sugar purity	Final molasses °Brix	Purity
4	90	1695	83.7	86.9	35.04
	123	2035	83.4	85.9	35.40
5	77	890	82.0	83.6	33.61
	129	1012	82.3	80.0	33.85

Table V. The effect of water temperature on centrifugal performance (average of 16 tests at Factory 3 and 14 tests at Factory 4)

Factory	Water temp., °C	Massecuite flow rate, kg/hr	Water % massecuite	C-sugar purity	Final molasses purity
3	81.5	1710	13.2	85.0	42.20
	55.0	1470	15.5	84.6	41.79
4	83.4	1660	9.4	84.6	38.61
	53.3	1550	10.0	85.1	38.16

Table VI. The replacement of steam by additional water at Factory 3 (average of 15 runs)

Steam addition	Open	Closed
Water % massecuite	7.6	10.5
Massecuite flow rate, kg/hr	1993	1915
C-sugar purity	82.6	83.0
Final molasses		
Brix	80.4	78.2
Purity	41.67	41.80

In both tests the molasses purity dropped by about 0.4 at the lower water temperature; this was accompanied by a reduction in throughput of 14% and 7% at Factories No. 3 and 4 respectively.

(d) Interchangeability of steam and water

In this series of tests at Factory No. 3, the steam admission valve, which is normally run fully open, was closed at every alternate run, and the addition of water at 80°C increased so that the capacity remained the same at the same *C*-sugar purity. The results are given in Table VI and indicate that, for all practical purposes, the replacement of steam by 38% additional water did not cause any change in *C*-molasses purity.

Crystal size distribution of C-*massecuites and molasses purity rise*

Regular surveys carried out during the first two years of the centrifugal investigation showed that, on average, the molasses purity rise across *C*-centrifugals in the industry was around four points. Based on the "dry run" test, the physical loss of small crystals through the screen perforations was found to account for nearly three of these four points of purity rise. Because of rhe importance of this loss, an investigation into the size optimization of the *C*-crystal population was initiated and consisted of two main parts:–

(a) an industrial survey of the crystal size distribution of *C*-massecuites, and

(b) an investigation to determine the effect of the crystal size distribution of *C*-massecuite on actual centrifugal losses.

Industrial size survey

The results of the survey carried out in the 1983/84 and 1984/85 seasons are summarized in Table VII. The mean width of the crystal population is based on a number distribution and the elongation factor is the ratio of the mean length to the mean width.

The survey showed that the size of the *C*-crystals was generally very small and in the second half of the 1984/85 season, a number of mills were persuaded to produce *C*-massecuites with a bigger crystal size as reflected in the table above. This size increase is exemplified by the results from one mill shown in Figure 2, in which the size distribution by number and mass is expressed on a cumulative basis.

Centrifugal investigation

Based on 43 different tests, it was found that there was good agreement between the total molasses purity rise (ΔP_t) and the purity rise resulting from the presence of small crystals in the molasses (physical loss ΔP_p). The relationship, illustrated in Figure 3, is given by the equation:–

$$\Delta P_t = 1.03\ \Delta P_p + 0.59$$
$$(r = 0.89,\ n = 43)$$

In the above equation 0.59 represents the operational losses, that is the molasses purity rise due to dissolution under general operating conditions at a *C*-sugar purity of about 82.

The size distribution of the crystals which passed through the screens is illustrated in Figure 4. The contribution

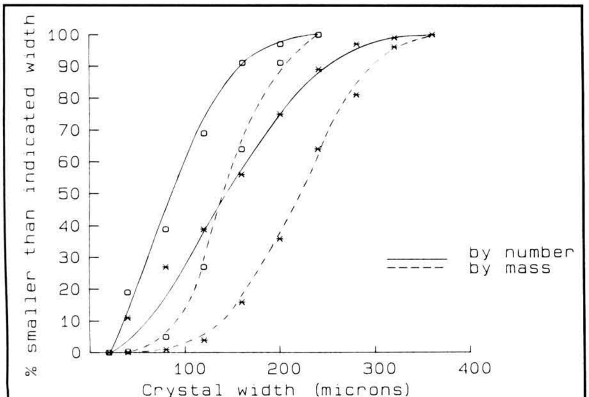


Fig. 2. Crystal size distribution of two *C*-massecuites: Masscuite 1, mean 98 microns; Masssecuite 2, mean 144 microns

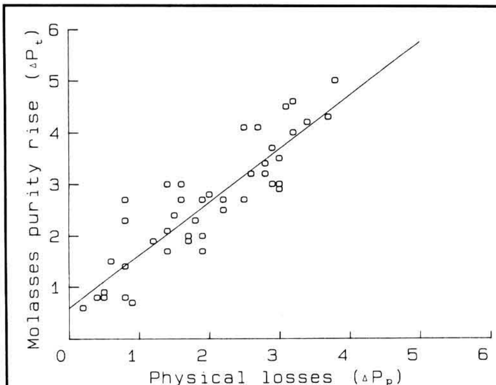


Fig. 3. The relation between the molasses purity rise (ΔP_t) and the physical losses (ΔP_p)

Table VII. Industrial monthly *C*-crystal size survey

	1983/84 season	1984/85 season	
	June - Dec.	June - Sept.	Oct. - Jan.
Mean width, µm	102	108	126
Elongation factor	1.7	1.6	1.8
%Total crystal smaller than 120 µm			
By number	73	65	52
By mass	36	26	15

Table VIII. The contribution of different crystal sizes to the physical loss

Crystal width, µm	% Total physical loss
20 - 40	10
40 - 60	18
60 - 80	20
80 - 100	22
100 - 120	16
120 - 140	14

of the different sizes of crystal to the mass loss is given in Table VIII.

Based on the above results, it was decided to choose 120 microns as a practical "cut-off" size for defining a small crystal in a *C*-massecuite.

It was found that an increase in the mean crystal size of a *C*-massecuite would reduce its content of these small crystals, expressed as a percentage of the total crystal content. The relationship between these two parameters is given by the following equation, which is also shown graphically in Figure 5.

$$\ln (M_{sc}) = 24.28 - 4.55 (\ln W_c)$$
$$(r = 0.97, n = 51)$$

where M_{sc} = mass of small crystals % total crystal content, and W_c = mean crystal width in microns.

Finally, as a logical consequence to the above findings, the quantity of small crystals in the *C*-massecuite was found to influence directly the molasses purity rise across a *C*-centrifugal as expressed by the following equation, which is illustrated in Figure 6.

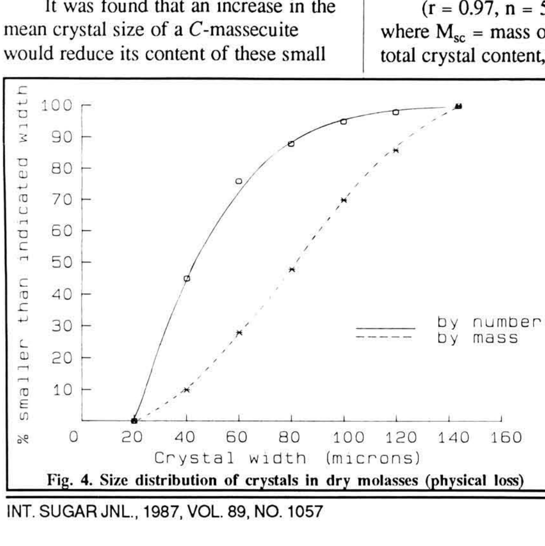


Fig. 4. Size distribution of crystals in dry molasses (physical loss)

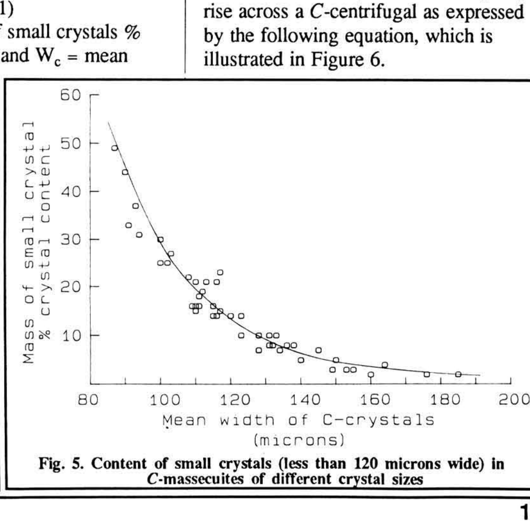


Fig. 5. Content of small crystals (less than 120 microns wide) in *C*-massecuites of different crystal sizes

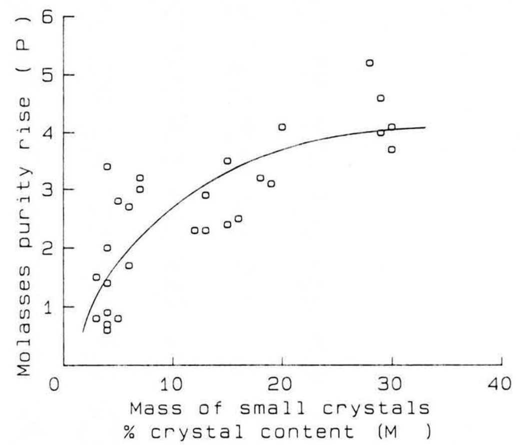


Fig. 6. The relationship between the molasses purity rise (ΔP_t) and the content of small crystalls (M_{sc}) in the *C*-massecuite

$$\Delta P_t = 1.25 (\ln M_{sc}) - 0.15$$
$$(r = 0.80, n = 29)$$

Conclusions

The three main factors found to have an influence on the molasses purity rise across the C-centrifugals were, in order of importance:– (i) the crystal size distribution of the *C*-massecuite, (ii) the C-sugar purity, and (iii) the massecuite throughput.

Undoubtedly the quality and condition of the screens would be another significant factor. However, this aspect was not covered in this investigation, where all the tests were carried out on screens which were either new or in excellent condition.

(i) Crystal size distribution

Most of the molasses purity rise, measured at up to five points, was due to the physical loss of small crystals in the molasses as shown in Figure 3. Consequently, the crystal size distribution of the *C*-massecuite, because of its effect on the content of small crystals, is of paramount importance. The operational losses were found to be relatively small at 0.6 purity at a *C*-sugar purity level of about 82 which is normal in the industry. The *C*-massecuites were found to have a high content of small crystals and it is felt that the local industry, in its endeavour to maximize molasses exhaustion, has reduced the crystal size of its *C*-massecuites too much. It has been recommended that the mean crystal width be increased to a minimum of 150 microns to reduce drastically the content of small crystals (see Figure 5).

(ii) *C*-sugar purity

The molasses purity rise was found to be directly dependent on the *C*-sugar purity. In the purity range of 75 to 88 every one point increase in sugar purity resulted in aproximately 0.1 rise in molasses purity. It was found that the molasses purity rise remained practically the same no matter what combination of operational variables was used to obtain an identical *C*-sugar purity. Consequently, at a fixed *C*-sugar purity, only small improvements in molasses purity can be expected through an optimization of the operational technique.

(iii) Massecuite throughput

Contrary to general belief, originating partly from the findings of Kirby[4] in Australia, it was found that to run the centrifugals at higher capacity resulted in a molasses purity rise at the same *C*-sugar purity. All the different methods used to obtain additional throughput, such as increasing the wash water temperature and/or the water addition and/or the steam addition yielded the same pattern. Overall increases in capacity of 10 to 50% were accompanied by molasses purity rises of 0.3 to 0.9.

Acknowledgements

The author would like to thank the process staff of all the South African mills for their assistance in this project. Mr. C. Rungasamy and the Analytical Services Division of the SMRI are thanked for the crystal size measurements and analytical work, respectively.

Summary

A series of factory investigations, intially based on a statistical approach, was carried out to determine the effect of various operational parameters on the performance of continuous *C*-centrifugals. The influence of steam, water addition and water temperature on the centrifugal performance is reviewed and a relationship between *C*-sugar purity and *C*-massecuite purity is given. The importance of crystal size distribution of the *C*-massecuite on the physical losses of small crystals through the centrifugal screen and its contribution to the overall molasses purity rise are discussed.

PERSONAL NOTES

We regret to report the death in November of **Dr. Ladislav Rosenberg**, at the age of 77. Born in what is now Yugoslavia, he studied in Novi Sad and Prague, and joined the Veliki Beckerek sugar factory in 1934 as a shift chemist, becoming assistant factory manager in 1941. After war service he returned to the factory (now renamed Zrenjanin) as technical manager but in 1948 emigrated to Israel where he was charged with planning and putting into operation of the Afula sugar factory. After 10 years in Israel he joined Sena Sugar Estates Ltd. at the Marromeu cane sugar factory and three years later became general superintendent of Ingenio Eldorado in Mexico. In 1966 he joined Stork-Werkspoor Sugar and was sent to Iran to commission the Neishabour sugar factory, returning to Holland to become advisor on sugar technology for SWS until his retirement in 1974. He then worked as independent consultant, remaining active in the sugar industry. He had travelled widely and had many friends all over the world who will be saddened at his loss.

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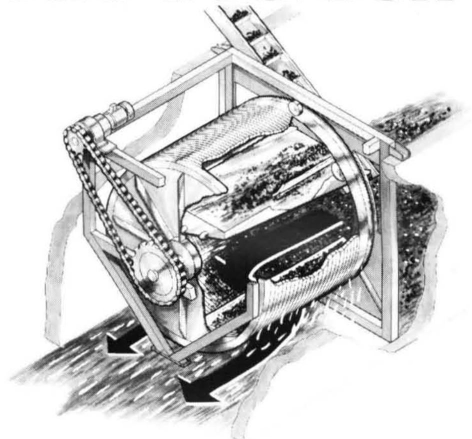

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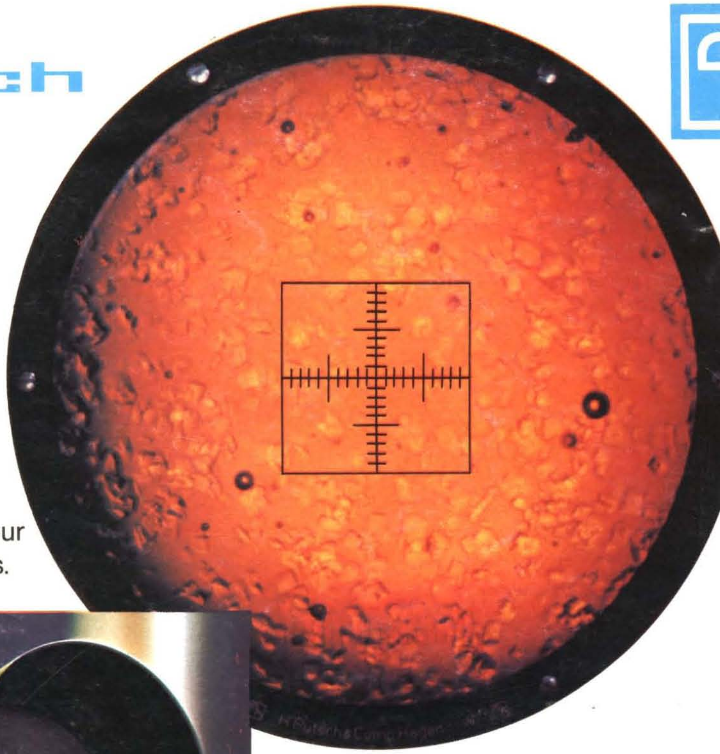

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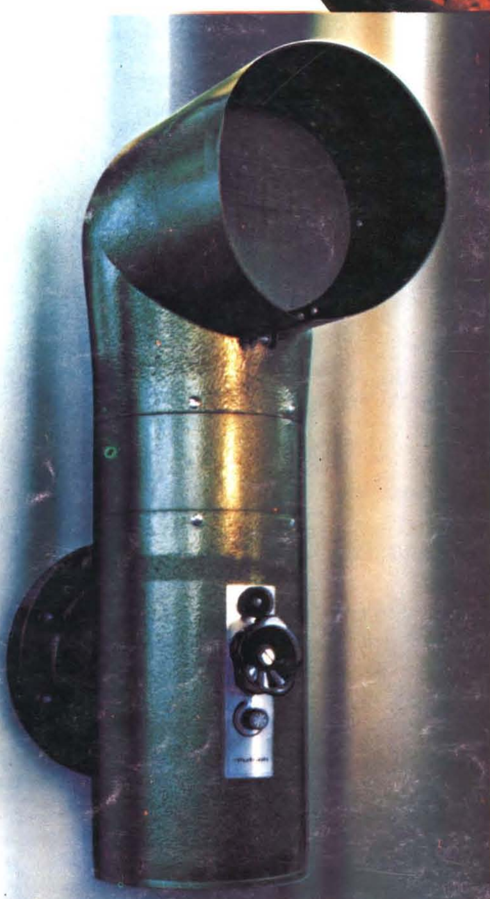

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