International Sugar Journal

Panel of Referees

THE
INTERNATIONAL
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NOTES AND COMMENTS

U.N. Sugar Conference.

A two-day United Nations Sugar Conference concluded in London on the 4th July with the adoption of the text of a protocol which would continue the existing International Sugar Agreement of 1958 in force for the two-year period ending on 31st December 1965. The present agreement, concluded in Geneva in 1958, is administered by the 43-member International Sugar Council and was due to expire on 31st December 1963.

The text of the new protocol provides for the study by the International Sugar Council of the bases and framework of a new agreement to succeed the present Agreement of 1958. In this connexion, a report will be made to all participating governments not later than 30th June 1964.

The new protocol will enter into force on 1st January 1964 if governments representing 60% of the votes of sugar importing countries and 70% of the votes of exporting countries have become parties to it.

The Chairman of the U.N. Sugar Conference 1963 was RALPH E. STEDMAN, Executive Director of the International Sugar Council. The Vice-Chairmen were RUBEN GONZALEZ SOSA of Mexico and H. J. SCHARMER of the Federal Republic of Germany. The Conference was opened on behalf of the Secretary-General of the United Nations by PEARCE R. JUDD.

The Conference was attended by delegations from 62 countries, of whom 10 were observers, as follows: Algeria, Argentina, Australia, Belgium, Brazil, Bulgaria, Canada, China (Taiwan), Colombia, Costa Rica, Cuba, Czechoslovakia, Denmark, Dominican Republic, Ecuador, El Salvador, Federal Republic of Germany, Finland, France, Ghana, Guatemala, Haiti, Hungary, India, Indonesia, Ireland, Italy, Jamaica, Japan, Republic of Korea, Madagascar, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Federation of Rhodesia and Nyasaland, South Africa, Spain, Trinidad and Tobago, Tunisia, U.S.S.R., United Arab Republic, United Kingdom and United States.

The countries sending observers were: Austria, Libya, Norway, Pakistan, Roumania, Sweden, Switzerland, Thailand, Turkey and Yugoslavia. Observers were also present from the International Labour Organization and from the Food and Agriculture Organization of the United Nations.

The Fifteenth Session of the International Sugar Council was held at the seat of the Council in London on the 5th July 1963. The Session was presided over by Dr. H. J. SCHARMER (Federal Republic of Germany), the Chairman of the Council for 1963. It was attended by representatives of thirty-six countries, by an observer from the Government of Jamaica and a representative from the F.A.O.

The purpose of the Session was to give effect to the decision taken at the U.N. Sugar Conference on the previous day. It will be recalled that in extending the life of the International Sugar Agreement of 1958 the Conference required the Council to study the bases and framework of a new Agreement. The Council therefore, recognizing the importance and urgency of this task, established a Prepatory Committee and directed that Committee to submit a progress report to the Council at its next Session.

The Council considered that it would be helpful to Governments to have a regular exchange of information regarding longer-term production plans and market requirements and decided to undertake this task.

At its next regular Session in November 1963 the Council, in accordance with its established practice, will, *inter alia*, undertake a full review of the market situation.

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Reduction of distribution payments on sugar.

The Ministry of Agriculture, Fisheries and Food announced on the 4th July that the Sugar Board's distribution payments on sugar were to be reduced from 56s 0d to 28s 0d per cwt of refined sugar (from 6d to 3d per lb) with effect from midnight. Corresponding reductions were made in the rate of distribution payments. The change was made because the world price of raw sugar had fallen by about 20s per

cwt from the peak it reached just before the distribution payments were introduced on the 30th May, and this had altered the Board's financial prospects. The change led to an increase of about 2d per lb in the ex-refinery price of sugar which brought prices to the levels ruling before the sharp rise during May.

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Booker Group 1962 Review.

British Guiana.—Until November the world price of sugar was below the relatively low average of the last ten years. Nevertheless Bookers Sugar Estates, producing about 267,000 tons of sugar (5-year average 258,000 tons), made healthier profits than in 1961. This was partly thanks to British Guiana's valuable 65,000-ton share in British West Indian sales to the United States, and partly due to rigorous pruning of expenditure in the early part of the year, forced upon the Company by low sugar prices; but it was mainly because they were able to reap, in higher efficiency and productivity, the benefits of economic planning and of new techniques designed and developed over the last few years.

It has been decided to try to raise total annual production of sugar in British Guiana by 50,000 tons over the next five years or so. In keeping with this plan for expansion, it is planned to extend and rebuild the Albion factory at a cost of about £1½m. This will take about four years: the first phase, the new mill, is being ordered this year.

Jamaica.—Innswood Estate, producing nearly 21,000 tons of sugar (5-year average 17,500 tons), had quite a good year but made rather less profit than in 1961 owing to a drop in the yield of sugar per acre. While the high world price should bring good profits to Innswood in 1963, continuing efforts are being made to improve efficiency in field and factory, and to institute effective cost control.

Nigeria.—The money has now been raised for the 30,000-ton sugar estate and factory at Bacita in Northern Nigeria being built up in partnership with the Nigerian Federal and Regional Governments. The company owning the estate and factory is the Nigerian Sugar Company.

At present the land at Bacita is being cleared and equipped; staff, Nigerian and expatriate, are being recruited; the irrigation and drainage works are being constructed; houses and roads are being built; and the factory is being supplied by Duncan Stewart—a Booker subsidiary. The translation of all these plans into practice is a formidable undertaking. If, as is hoped, everything goes according to plan, the first cane should be reaped, and the first sugar made, at the end of 1964.

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Colombian sugar expansion[1].

The presidents of the Corporación Financiera Colombiana de Desarollo Industrial, the Financiera Nacional de Medellín, the Corporación Financiera del Valle, la Corporación Financiera de Caldas, and the Corporación Financiera del Norte made a joint statement early in June that they were prepared to finance the development of the sugar industry, particularly in the Valle del Cauca and the Valle del Zulia, as a means of contributing to the diversification of Colombia's exports. The corporations will sponsor the formation of new companies and will examine the possibility of enlarging existing sugar mills.

It was estimated in the statement that there are in the Valle del Cauca more than 450,000 hectares suitable for the mechanical cultivation of sugar cane whereas at present less than 50,000 hectares of the area are planted to cane. Within seven years Colombia could have an exportable surplus of up to 3,200,000 tons of raw sugar which at present prices would be worth \$700 million or about double the current proceeds from coffee exports.

As a result of the present shortage of sugar, which in some instances has been aggravated by speculators, prices have risen to 1·10 pesos per pound, whereas the prices authorized by the Superintendencia de Regulación Económica are from 60 to 70 centavos per pound.

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Demerara Company Holdings Limited, 1962 Report.

1962 was a difficult year for the Estates, in that a severe drought curtailed the spring crop considerably and as forecast the crop was smaller than in 1961 (at 58,808 tons, compared with 59,506 tons). Diamond was affected rather more than Leonora, because the water supply position there is particularly critical under drought conditions. The Estates have been asked during the last few years to produce maximum crops to benefit from the markets available. Their success reflects great skill in planting. All available land is under sugar so that the acreage cannot be increased. Instead the yield per acre has to be raised by still better planting and by increasing factory efficiency. The problem of maintaining crop is made more difficult by continual demand for cane lands for housing schemes on the outskirts of Georgetown.

After five years of dry conditions, normal heavy rains early in 1963 delayed the commencement of crop operations, but this additional rainfall during the growing period, together with the effect on the water conservancy, should have a beneficial effect on the total crop for the year 1963 provided that conditions remain reasonably normal for the remainder of the year.

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Bagasse newsprint for Queensland.

The Minister for Labour and Industry, Mr. A. DEWAR, announced on the 19th May that the Queensland Government was negotiating for a new £A17 million industry at Mackay which would use bagasse for the production of 60,000 tons of newsprint per year. Negotiations with United States and Australian interests have been going on for six months and it is hoped that these will be finished soon.

[1] *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 620–62).

A REVIEW OF RECENT DEVELOPMENTS AND TRENDS IN SUGAR CANE AGRICULTURE

Chairman's Address to the Agricultural Section, International Society of Sugar Cane Technologists, 11th Congress, Mauritius, September-October 1962

By Dr. H. EVANS, O.B.E., D.Sc. (Agricultural Director, Bookers Sugar Estates Ltd.)

PART III

Phosphorus

It is likely that any one of several tissues would be adequate to determine gross deficiencies in phosphorus content. However, there is now little doubt that the choice of leaf sheath was an unfortunate one for phosphorus, since it is probably one of the poorer diagnostic tissues for this element. The close agreement obtained with respect to critical leaf lamina phosphorus from countries as far apart as Mauritius, Jamaica, British Guiana and Natal supports the view that leaf lamina phosphorus content, when no serious climatic limiting factors exist, is a satisfactory index of phosphorus status.

In my view it seems unnecessary to invoke an index based on analysis of more than one tissue and involving an empirical calculation such as that involved in CLEMENTS's A.P.I. (amplified phosphorus index) although this procedure may well provide a good yardstick of phosphorus status.

As would be expected the phosphorus content of the 8-10 internodes appears to give a good index of phosphorus status and in particular seems to be well correlated with available phosphorus in the soil as determined by a modified Truog method (BAVER 1961).

Like nitrogen, phosphorus uptake is greatly affected by rainfall conditions when ambient temperatures are optimal. Foliar phosphorus may drop from 0·20% P to as little as 0·12–0·13% P when drought and salinity conditions are present; good rainfall for 4–6 weeks may raise the leaf phosphorus back to 0·20% P again. Stalk phosphorus is equally seriously reduced under such conditions. This simply emphasizes the basic principle that mineral diagnosis can only be made safely and effectively when there are no over-riding climatic limiting factors to growth.

Attempts to use tissue analysis irrespective of age, climatic conditions, etc., as a single yardstick to the well-being of the cane are doomed to failure, but evaluated under conditions where mineral inadequacy exists and taking due consideration of other factors there is little doubt that the technique excels over all others.

With respect to elements other than N, P and K, considerable responses to limestone over and above that expected from its calcium nutrient content have been reported from Hawaii (CLEMENTS 1961, AYRES 1961, RIXON and SHERMAN 1962) and interpreted as being at least partially due to reduction in manganese and/or aluminium uptake. Certainly free aluminium ions in the soil may seriously affect root growth even in low concentrations. Damaging effects due to excessive manganese have recently been found by French workers to be largely affected by the content of silica. Silica may not only protect plants from toxic manganese concentrations but may also bring about manganese deficiency symptoms at higher levels of manganese than is the case at low silica contents.

SOIL INVESTIGATIONS IN RELATION TO SUGAR CANE AGRICULTURE

Opinions appear to differ on the value of soil chemical analysis in relation to the mineral nutrition of sugar cane. The H.S.P.A. investigators found a good correlation between available phosphorus by their modified Truog method and tissue phosphorus and also between available soil potassium and responses to applied potassium. CLEMENTS (1961), on the other hand, regards chemical soil analyses to determine crop requirements as being not only valueless, but distinctly misleading.

There is no doubt that serious limitations exist in presently available methods of determining nutrient availability in soils. For example, good crops of cane are often reaped on areas of British Guiana clays which show little or no available phosphate by the Truog method and soils differ in their ability to supply potassium according to the existing climatic conditions. Availability of potassium is not only greatly affected by magnesium antagonism, but is also seriously reduced with increasing hydration of montmorillonitic clays.

The Bureau of Sugar Experiment Stations in Queensland has also shown available potassium in the soil to vary considerably (two to three-fold) at various times during the year and has emphasized that samples must be collected at a standardized time of the year. One may well ask how far differences in climatic conditions between years may further compromise the data. The value of soil analysis is greater in soils where there are no serious physical limitations. Where the varying physical conditions of the soil in response to climatic conditions seriously affect nutrient availability, or where there are effects which seriously influence root function the results of soil chemical analyses may become very difficult to interpret. Accordingly serious shortages of nutrients may, in certain circumstances, result from root infections and infestations or from inadequate oxygen tension in soils which by chemical analyses show adequate contents of the elements under considera-

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tion. On the other hand, the extent of soil toxicity due to sulphates of aluminium and of iron in British Guiana acid sulphate soils can be forecast fairly reliably from soil analyses, since it is the proportion of aluminium in relation to calcium and magnesium in the exchange complex that determines the extent to which aluminium toxicity affects root growth.

The sugar cane plant will provide the information that it is inadequately supplied with this, that, or the other nutrient, but tissue analyses cannot further supply the answer as to why it is deficient. Frequently this may be due to an inadequate supply at its disposal and supplementary fertilizer would then be called for but on other occasions the answer may lie in the particular physical, chemical or microbiological status of the soil, when ecological, microbiological and soil investigations will be necessary to find the solution.

Any restriction of root growth such as by limited root space, defective absorbing function through nematode or fungal attack, or metal toxicity such as aluminium-induced coralloid rootlets, unfavourable levels of microbiological activity, inadequate root aeration, movement of nutrient ions into clay lattices, precipitation of ions in insoluble and unavailable form, antagonism between ions in the soil solution, may one and all result in inadequate mineral nutrition of the cane plant and a knowledge of the operative cause is essential if permanently adequate corrective measures are to be taken.

SUGAR CANE PHYSIOLOGY AND BIOCHEMISTRY

The original Clements Crop Log introduced some very useful physiological criteria of growth which were meant to follow the qualitative as well as the quantitative aspects of growth. Of these, the importance of high tissue moisture during the growth phase and the requirement of gradual water stress and lowering of tissue moisture during the ripening phase has been widely confirmed.

BAVER has pointed out that there is a high correlation between the moisture content and the reducing sugar content of the 8-10 internodes ($r = + 0.85$) and that as the moisture content declines so the sucrose/reducing sugar ratio increases; the relation between 8-10 moisture and sucrose/reducing sugar ratio is close ($r = + 0.939$), particularly during the growth phase. Unfortunately during the ripening phase when 8-10 moisture is 73-75% the ratio can vary between 20 and 50 with no significant changes in the moisture content so that the relationship is of limited value in ripening control procedures.

In Hawaii, it has also been recently shown that the moisture content of joints 4-5 is the highest of all parts of the plant and apparently unlike 8-10 joints its moisture content is independent of nitrogen. The moisture content of these joints is quickly sensitive to moisture stress; fortunately it is also highly correlated with the moisture content of leaf blade No. 1 (93–94% moisture in 4-5 joints corresponding to about 76% moisture in leaf 1).

In India it has been shown that best quality was obtained when irrigation was adjusted so as to give 280% hydration of the sheath (i.e. maintain sheath moisture of 73·7%).

Other Indian workers have claimed that peak maturity is best demonstrated by a high $\frac{\text{levulose}}{\text{glucose}}$ ratio (RAO and GOPALA AIYAR, 1962).

There has been marked interest in the fundamental physiology and biochemistry of sugar cane within the last three years. This is understandable since further progress in sugar cane agronomy other than the application of known knowledge will be limited until much more is known about the basic physiology of the cane with respect to its growth and its metabolism. VLITOS and CUTLER (1960) in Trinidad have greatly extended our knowledge on growth substances in sugar cane and have demonstrated the existence of growth inhibitors as well as growth promoters in cane and have shown that the auxins present in sugar cane fuzz are different from those which are dominant in the growing cane.

The opening of the David North Plant Research Laboratory, directed by Dr. GLASZIOU and financed by the Colonial Sugar Refining Co. Ltd., in Queensland for the study of climatic factors in the growth and metabolism of sugar cane provides a landmark in physiological studies of this crop; since although limited modification of climatic factors have been made possible in Louisiana to study arrowing and in Hawaii, both to study arrowing and to determine the influence of root and shoot temperatures on mineral nutrition, the Queensland phytotron makes it possible for the first time to grow sugar cane under strictly controlled conditions and enable the effects of climate factors to be isolated and evaluated.

The application of well established techniques on uptake of nutrient material by tissue slices, originated by Prof. WALTER STILES at Birmingham, has been shown to be a useful tool for the study of absorption and transformations of carbohydrates in sugar cane stalks particularly by BIELESKI (1960) and by GLASZIOU (1960, 1961) in Australia.

The former has shown that sugar uptake by slices takes place in two stages, the first a movement into the apparent free space and the second an active accumulation process accompanied by an increased respiration rate and capable of operating against a 100-fold concentration gradient. Young stalk tissues had the greater capacity for uptake, mature slices being unable to accumulate sugars to any appreciable extent. The mechanism of accumulation thus appears to have much in common with uptake and storage of mineral elements in tissue slices of carrot and beetroot.

GLASZIOU using radio-active labelling showed that glucose in the inner space originated from inversion of sucrose. He indicated that there were two paths for sucrose uptake in young tissue depending on whether the outside concentration was high or low

and a working hypothesis was postulated entailing a carrier which facilitates the movement of sucrose from the outer to the inner space across the barrier which is believed to be the tonoplast membrane.

Transformations of sugars in young sugar cane stalk tissues are unbelievably rapid and appear to be sensitive to the usual inhibitors of enzyme systems.

Using labelled CO_2 the H.S.P.A. Experiment Station has shown that malic acid in addition to phosphoglyceric acid is an intermediate in sucrose synthesis. It has also been shown that sugars photo-synthesized in the very youngest leaves are mainly used for fibre formation in the youngest joints. Those joints in the process of maturing, i.e. joint No. 8 and adjacent joints, retain the greatest proportion of the sucrose made on any given day but an appreciable amount of the sugar made is stored in older joints.

The sugar synthesized appears to be divided into two almost equal portions, one portion going to build fibre in both rapidly expanding joints and in maturing joints. It is particularly interesting to note that the laying down of hemicelluloses in cell-wall material is still going on in joints down to joint No. 16.

These biochemical techniques aided by the use of tagged elements are invaluable in bringing about a proper understanding of the factors affecting sucrose accumulation in cane although it may be a very long time before the possibility of modifying normal metabolism favourably to influence the cane plant's carbohydrate metabolism may be accomplished.

In the meantime many investigators have tried to achieve a greater accumulation of sucrose by empirical treatments and claims of success are reported from time to time. Applications of 2,4-D were reported to have increased sucrose content in several countries, and favourable reports have since been issued for phosphate sprays, mineral oils and other herbicidal products, but as far as I am aware no country is using such techniques as part of its normal sugar production technique. Probably, the failure to date of finding an effective growth inhibitor for sugar cane which will enable growth to slow down without undesirable side-effects, is responsible for lack of progress in this direction, but it is an object well worthy of investigation. In short we need an inhibitor that is as effective in its rôle of growth inhibition as the giberellins are in growth promotion.

Work has continued in several countries on the potential losses of sugar which the cane has syn-thesized. In Louisiana where losses from stale cane appear to be high, cane milled five days after cutting gave 15% less recoverable sugar, whilst in the Domini-can Republic losses of sugar over 6 days averaged 12 lb per ton of cane per day for B 4337 and 9 lb for B 37161. Attempts to reduce the trash content of cane are being followed up in several countries: in British Guiana Work Study recommendations involv-ing control charts of trash content of sample bundles are being used with accepted tolerances and warning mechanisms when trash content is approaching unacceptable limits. However, it is the increased trash content accompanying mechanical harvesting and loading that poses the greatest problem at present.

BIRKETT (1962) in British Guiana has carried out an extensive investigation of the effects of immature tops and trash on quality and factory costs of prod-uction. The samples examined averaged 84% clean cane, 11% tops and 5% trash; there was a drop in apparent purity from 84·21 in the clean cane to 82·07 in the gross cane. Trash was of far more importance in milling costs than the tops and resulted in very appreciable economic losses.

In Hawaii "trash + tops" ranged from 12% with a good burn to as high as 30% with no burn. In comparison with net cane the burnt cane with 12% trash content showed 2% lower purity and with the unburnt cane with 30% trash a purity drop of $3\frac{1}{2}$%.

In an attempt to solve this trash problem, pre-harvest chemical desiccants are being tried out on a large scale. Some of the newer compounds, particu-larly "Reglone" and "Gramoxone" seem to hold promise for sugar cane.

PROGRESS IN MECHANICAL HARVESTING AND LOADING OF SUGAR CANE

Developments in mechanical harvesting in Hawaii have centred round the cut-convey-load principle which cuts the cane and discharges chopped cane into a transport truck. Experimental machines of this type have given very good performance (over 100 tons of cane per hour cut and loaded) and seem the best answer for irrigated cane. For unirrigated cane harvesting, two types of operations are being investigated—the cut-convey-load system mentioned above and a cut-transport-transload system in which the cane will be transloaded into trailers spotted in-field by means of a self-unloading track-type cane buggy.

A prototype of the latter design is now being built.

A direct mounted harvester for planting material is already in commercial use.

Louisiana has had considerable success in inte-grating mechanical harvesting operations suited to its own agricultural lay-out which is likely to be widely adapted in areas to which the Louisiana system of cane cultivation is well adapted. The single row type of cane harvester is a very efficient machine, the topping operation being the least efficient part of its performance. It is, however, designed to operate on comparatively light stands of erect cane.

Loading is a separate operation, several types of loaders being available. Engineering firms in Louisi-ana are engaged in modifications of harvesters and loaders to enable them to work in conditions differing from those in Louisiana (e.g. different inter-row spacings had made application of Louisiana machines in Australia difficult).

In Florida cane cutting is still carried out by hand, although trials with Louisiana equipment are in progress. The high tonnages and recumbency of

cane in Florida together with the friable soils represent a situation where mechanical harvesting problems have not yet been overcome.

In Australia a wide range of harvesting machines is under test and many are in commercial use; like Louisiana fairly light stands of erect cane result in simpler problems of harvesting mechanically. However, at least one of the machines under trial, the New Toft harvester, has a new attachment known as the "down cane variable pick up" attached to the front of the machine to deal with lodged and sprawling cane.

Considerable numbers of the Massey-Ferguson "chopper harvester" have been in use recently, wherein the cane is chopped into short lengths and then elevated for loading into a towed trailer-mounted bin. Locally made harvesters such as the Fairymead, the Venton, the Toft, the Crichton and the Maxmor indicate the versatility with which the Australians are tackling their cane harvesting problems.

A harvester known as the Cary harvester has been under trial in South Africa—this machine tops, cuts and loads cane and is said to handle lodged canes in the rows. It requires two operators. However, both in Australia and in South Africa mechanical harvesting is still in its infancy, there being less than 5% of the crop harvested by machine.

Mechanical loaders on the other hand are widely used and their use is extending in Peru, Brazil, Australia, Taiwan, South Africa, Puerto Rico, in parts of the West Indies and in several other sugar cane growing areas.

Mr. G. S. BARTLETT has a paper describing mechanization of loading and transport in South Africa before this Congress and Mr. R. A. DUNCAN will describe the latest developments in Hawaii.

In summary, I think that it is true to say that advances in field mechanization follow the sequence:

(1) increasing the productivity of the cane cutters by aiding in the carriage of cane from the field to the transport equipment;

(2) improving the transport of cane from the field to the factory by better loading methods and better transportation;

(3) improving the productivity of the harvesting operation by the introduction of mechanical cutting which added to (1) above increases still more the productive capacity of the cane cutter;

(4) the designing of a machine that not only cuts the cane at ground level but also tops it at the optimum point. At present light machines that accomplish this with reasonable efficiency only work on reasonably erect cane and on not-too-heavy stands. With infield loaders, outfield loading devices and efficient field to factory transportation this completes the mechanization of uniform upright cane of moderate stands—examples are Louisiana, Australia, and, experimentally, Puerto Rico, S. Africa, etc.;

(5) the designing of a machine that is able to pick up, cut and chop heavy stands of recumbent cane and pass it directly into conveyor trucks which proceed to the factory. Trash is removed by a high velocity air current. This type of machine has been perfected and is in limited use in Hawaii and models of it are being manufactured for certain South American countries, e.g. Peru.

Such machines are, of necessity, heavy and can only be used on suitable terrain and in areas where labour costs are high, and where quality of cane is good.

Summarizing, one may state that future progress from the agricultural side will depend on a steady stream of new and superior varieties, better control of pests and diseases (both aspects which have not been considered in this address since they fall within the sphere of other sectional chairmen), a better understanding of the sugar cane plant in relation to its environment; the identification and correction of local limiting factors to growth and quality; elimination of competitive weeds and the provision of optimal economically-feasible conditions for high productivity; fundamental investigation and elucidation of those biochemical and physiological processes within the plant that lead to the accumulation and storage of sucrose so that, with an understanding of the basic physiology, means of guiding it in the most effective manner may be known, and finally the harvesting of the sugar that is produced in the field by the most economical means and with the smallest avoidable losses.

AGRICULTURAL ABSTRACTS

Biotypes of *Cynodon dactylon*, **1 and 2.** F. ROCHE-COUSTE. *Occ. Paper Mauritius Sugar Ind. Research Inst.*, 1962, (10), (11); *Weed Research*, 1962, **2**, 1–23 and 136–145.

Cynodon dactylon is a grass of very vigorous growth which readily adapts itself to varied ecological conditions and which has now become a troublesome weed in many tropical countries. Earlier studies have shown that it exists in several biotypes. The first paper constitutes a study of these biotypes and it is found that, beside morphological differences, cytological differences exist, including triploid and tetraploid forms. Physiologically, a seasonal trend exists in carbohydrate reserves which is linked with rhizome growth.

In the second paper is reported the response of these biotypes to TCA and "Dalapon," both formulated as the sodium salts. The tetraploid biotypes proved more resistant. Phyto-toxicity was not increased by wetting agents, whether non-ionic, cationic ar anionic. Bud dormancy through root uptake is shorter in the tetraploid forms.

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A method of improving water soakage. G. A. CHRISTIE. *Cane Growers' Quarterly Bull.*, 1963, **26**, 78.—The use of transverse check banks, or "chocks", to retain water is briefly described and illustrated. Certain contingent disadvantages are noted.

SUGAR CANE BREEDING

British West Indies Central Sugar Cane Breeding Station, Barbados, 28th Annual Report, 1960-61

THE report records another year's progress along lines which have become almost standardized. The use of plastic bags for potting has been adopted on a considerable scale; while growth in these was superior to that in clay pots, field survival was not good. Crosses involving *S. sinense* were used extensively, that species in the past having contributed largely to the bulk of promising seedlings. Planted in the field were 40,256 singles and 1,344 bunches. In the first year seedling trials, B 62' series, 6323 seedlings were planted. It is only in the second year harvestal trials (B 59' series) that individuality begins to express itself and tabulated data, including standard varieties, are given of the results of the B 58' ratoons.

Variety testing proper, as opposed to seedling selection, begins with the B 57' series, the plant cane results of which and also the second ratoon results of the B 55' series (no selections of the B 56' series passed the test) are tabulated.

Research work

The work on in-breeding was continued with the raising of the sixth generation of selfs. In-breds are used for crossing with varieties of proven breeding values. The problems involved, both in the cytological and practical fields, are shown to be very complex and are only briefly discussed.

In the cytological studies, certain modifications in technique are outlined. Chromosome counts of several clones with doubtful determinations and of a new Indian *spontaneum* clone were also made. Further work on the in-bred lines in the fourth and fifth generations gave confirmation of the previous finding that chromosome numbers tend to stabilize at a lower figure than that of the foundation parent.

In crossings, the solution used was mainly 80 p.p.m. SO_2 and 50 p.p.m. H_3PO_4, changed thrice weekly. Trials with SO_2 strengths ranging from 20-120 p.p.m., with and without painting of the stalks with synthetic rubber latex, suggested that highest strength was optimum though high mortality rendered statistical comparison impossible.

A large series of experiments was conducted in an attempt to evaluate competition in bunches, using for the purpose single-eye pre-germinated material and comparisons made with single plantings. The full data are given in tabular form but, unfortunately, lead to no significant conclusion.

An analysis of the planting of 26 families of the B 61' seedlings as bunch or singles, involving a somewhat intricate statistical analysis, leads to the conclusion that bunch selection is inefficient as a means of assessing a family.

Other matters briefly touched on are: the relation between parents and progeny at the two levels of fertilization, hot water treatment and variety comparisons from factory data.

The report ends with a statement of varietal trends in the various contributing territories. With two exceptions, 2% of acreage under Co 331 in Jamaica and 1·6% under Pindar in British Guiana, the entire crop is composed of clones of the B series.

The three appendices list in full detail the germination and plantings of the B 63' series, the first year seeding trials (B 62' series) and final selections from the B 61' series.

H. M.-L.

AGRICULTURAL ABSTRACTS

Five essentials for economy in irrigation. G. Y. EWART. *Sugar Research and Management*, 1962, **4**, (3), 2 and 3.—The author concentrates on developments in the Hawaiian flow irrigation system, the major point around which the discussion centres being the manner in which the more permanent features of the layout shall be cost-accounted.

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Effect of date of spring dirting on yields. L. P. HEBERT and R. J. MATHERNE. *Sugar Bull.*, 1963, **41**, 97–101.—The term "dirting" refers to cultural practices early in the season for the preservation of tilth and control of weeds. Though statistically significant differences were found in the number of tillers in June, both between early and late dirting and between early and late-tillering varieties, yield differences failed to appear in the final crop. An alternative practice is suggested in which an early dirting is followed by herbicidal applications.

Nutritional requirements of sugar cane variety Co 312 by foliar diagnosis. A. WAHHAB. *Pakist. J. Sci. Res.*, 1961, **13**, 103–106; through *Soils and Fertilizers*, 1963, **26**, (1), 497.—Foliar N, P and K contents were determined for plants grown at different fertilizer levels. Maximum yield followed the N application which gave a leaf-N content of 1·6% and the K application giving a leaf-K level of 2·0–2·2%. There was no response to added P; leaves contained about 0·4% P.

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Kenaf trials in British Guiana. G. D. BAXTER. *Trop. Sci.*, 1962, **4**, 205–215.—Kenaf (*Hibiscus cannabinus*) has been shown to be a crop fitting well into the sugar cane rotation as practised in Natal[1]. These further trials, as reported from British Guiana, with the conclusions drawn, may, therefore, have an interest over a wider area.

[1] *I.S.J.*, 1963, **65**, 99–101, 131–134.

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Agricultural Abstracts

Experiments to improve irrigation. L. G. Vallance. *Cane Growers' Quarterly Bull.*, 1963, **26**, 76, 77.—In this brief note examples are given of lack of penetration through the build-up of sodium. This is dispersed by a pre-planting application of 4 tons gypsum per acre. The striking difference in growth is shown in the two illustrations.

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Earth pearls. N. McD. Smith. *Cane Growers' Quarterly Bull.*, 1963, **26**, 84, 85.—The earth pearl is the encysted stage of a mealy bug (*Pseudococcus sp.*) and may occur in great numbers. It is thought to be responsible for poor cane growth on the Bundaberg red volcanic loams. The life history is described and thorough cultivation during the hatching season to expose the eggs is considered the best control.

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A new variety. H. G. Knust. *Cane Growers' Quarterly Bull.*, 1963, **26**, 79.—The variety is the Hawaiian cane H 48–3166. On three types of soil it has outyielded, both in tons cane and tons sugar per acre, all the varieties with which it was compared. In the single ratoon crop recorded, on red volcanic soil, it was outyielded on both heads by Q 47. In a further anonymous article (pp. 86–88) descriptions are given of three more varieties Q 74, Q 76 and POJ 2961. Another brief note describes and illustrates an erect seedling, 54 N 6434.

* * *

Soldier fly investigations 1961–62. R. W. Mungomery. *Cane Growers' Quarterly Bull.*, 1963, **26**, 102, 103.—In a field subjected to the same cultural procedure, including BHC application, half of which had a 10 month, and the other a 6 weeks' fallow, growth in the latter was poor, owing to large numbers of solider fly larvae. The moral drawn is that insecticides do not always make up for poor cultivation.

* * *

Airplane applications of herbicides for Johnson grass control in Louisiana sugarcane. E. R. Stamper. *Down to Earth*, 1962, **17**, 24–26; through *Hort. Abs.*, 1962, **32**, 966.—Effective control in heavily infested plant cane was obtained by aerial spraying with "Dowpon" (3 lb plus "Silvex" 1 lb/acre/3 gal). "Dowpon" (5 or 6 lb/acre/5 gal) also controlled Johnson grass originating from rhizomes in stubble cane. Results with aerial spraying were as effective as those obtained when equal amounts of herbicide were applied to the drill with ground machines. The sodium salt was more effective than the ester.

Sugar cane fertilizer experiments in 1961. L. G. Davidson. *Sugar Bull.*, 1963, **41**, 85–91.—The results of 12 experiments conducted by Houma Station are summarized and tabulated. Six of these are N × variety trials. In these no significant interaction was found for the 5 varieties included.

* * *

Weed and grass control in sugarcane in Louisiana. E. R. Stamper. *Proc. 14th South Weed Conf.* 1961, 98–103.—"Fenac" at 2–3 lb/acre applied pre-emergence to the drill ($\frac{1}{3}$ of total area) in plant cane gave good control of all weeds and grasses for several months. Two applications of TCA + "Dalapon" + 2,4-D were required to ensure effective weed control. With Johnson grass seedlings "Fanac" pre-emergence at 3 lb/acre resulted in mean yields of clean cane at 25·9 tons/acre compared with 15·7 tons for untreated controls.

* * *

The effect of gibberellic acid on roots. I. The effect of a gibberellic acid-lanolin mixture on root development of sugar cane cuttings. C. A. Blesa and L. Recalde. *Phyton. Argentina*, 1961, 16, 183–188; through *Hort. Abs.*, 1962, **32**, 724.—In experiments at Granada, Spain, on one-bud setts of POJ 2727, taken one day and one week before treatment with GA-lanolin mixtures at 0·1, 1·0 and 10·0%, the best results were given by the 10% mixture in both cases. They were more spectacular with the week-old setts as these scarcely rooted without treatment; with the 10% mixture the number and mean length of roots were 58 and 0·9 cm, whereas the corresponding figures in the control were 1·0 and 0·2 cm.

* * *

Cane yield as affected by the frequency of tractor cultivation in different soil types. T. P. Pao, Y. T. Lee and L. Y. Lin. *J. Agric. Assoc. China*, 1961, (34), 38–45; through *Hort. Abs.*, 1962, **32**, 725.—Four to five cultivations during the growing period did not significantly increase yields on sandy, sandy loam or saline soils, but gave increases of 7·84–10·9% and 7–11·35% on heavy clay and red soils respectively.

* * *

Composts for sugar cane. J. C. Skinner. *Cane Growers' Quarterly Bull.*, 1963, **26**, 104, 105.—Confirmation is given to the fact, to which attention was drawn by the John Innes Institute, that sterilization of mixtures of soil and compost produces harmful nitrogenous products which may be neutralized by adding superphosphate. The organic component may be sterilized before mixing, when better seedling germination was obtained.

COMMISSION INTERNATIONALE TECHNIQUE DE SUCRERIE

12th General Assembly

THE 12th General Assembly of the ˚C.I.T.S. took place in Paris during 17th–20th June 1963. Delegates were present from 21 countries, including Austria, Belgium, Czechoslovakia, Denmark, France, Germany, Holland, Iran, Ireland, Italy, Japan, Poland, Roumania, Spain, Sweden, Switzerland, Turkey, U.K., U.S.A., U.S.S.R. and Yugoslavia. Meetings were held in the Centre de Conférences Internationales du Ministère des Affaires Etrangères, Avenue Kléber, simultaneous interpreting from and into the official languages—English, French and German—being available to participants (Fig. 1).

Fig. 1   [*Photo*: Hallery]

With Professor J. DUBOURG in the Chair, the first meeting of the Assembly opened with a welcoming address by M. LESAFFRE, President of the Syndicat National des Fabricants de Sucre de France, who then introduced M. J. PAUL, President of the Administrative Committee of the C.I.T.S. M. Paul spoke of the work and developments of the Commission and asked delegates to stand in silence for one minute as a tribute to the late President of the Scientific Committee, Prof. J. DEDEK.

Thereafter, Professor J. E. COURTOIS described the action of periodic acid on the glucides—polyols, including sugars—and showed how the action of this oxidizing agent threw light on the structure of such

materials. Delegates were then invited to a cocktail party to close the first session.

On the following morning, Prof. H. HIRSCHMÜLLER took the Chair and introduced Dr. R. PIECK, who gave a general report surveying the formation of colour in the sugar factory. This was followed by another paper from Tirlemont, introduced by J. HENRY, discussing the formation of colour during diffusion, together with its inhibition by treatment of the beets with SO_2. Prof. V. PREY described his work on the isolation of colouring matter from thin juice with decolorizing resin, together with investigations into its nature and constitution. Destruction by heat of glucose and sucrose in alkaline solution was the theme of the next paper by Prof. J. DUBOURG, while a further paper by Drs. PIECK and HENRY described the influence of the presence of SO_2 on the alkaline degradation of glucose. The morning session closed with a description by Dr. H. SCHIWEK of the properties of a "colour body acid" which he had isolated from regeneration liquors from two anion exchange resins used to treat green syrup and thick juices.

After lunch, the first speaker, introduced by the Chairman, Prof. P. M. SILIN, was Dr. M. KAMODA, who presented the paper by his colleagues, Drs. YAMANE and SUZUKI on their investigations of the nature of a dark brown colouring matter isolated from the regeneration brine from anion exchangers. Drs. PIECK and HENRY then described their work on the heating of sucrose solutions in an autoclave up to 135°C and the influence of various factors on the colour formation that occurred.

Professor F. SCHNEIDER then presented his paper on the isolation and investigation of colouring matter from molasses using ion-exchange and "Sephadex" separation techniques. A description was given by J. OLDFIELD of the work done in the British Sugar Corporation research department on the amino-acid deoxyfructoses which they had identified in molasses and which were intermediates in the formation of colour by the Maillard reaction, as well as comprising some 30% of the reducing substances in molasses. The final paper of the day was presented by Dr. H. ZAORSKA, who described the isolation of individual colour bodies from activated carbons and decolorizing resins, on which they had been absorbed, and the

examination of their comparative effects on the crystallization of sucrose under standard conditions.

On the following morning, with Prof. SCHNEIDER in the Chair, Prof. SILIN presented a general report on the formation of molasses, describing in particular the development and use of the "standard molasses" concept for comparison of factory operations. Mr. VAN DER POEL then described the work of himself and his colleagues at Breda using their laboratory diffusion unit, with which they had studied the extraction of sucrose and individual cations by deionized water, together with the effects of adding various salts.

Dr. SCHLIEPHAKE of the Braunschweig Sugar Institute described his work on the structure of aqueous sucrose solutions and the influences of the forms of hydration on the theory of molasses formation. The concept of molasses composition in terms of a partition coefficient for sucrose "solubility" in non-sugars and in water was introduced by Dr. F. HEITZ, after which Dr. R. CAROLAN described recent work in Ireland on the laboratory exhaustion of molasses and the relationship between the final purity and Na, K and Ca.

After lunch, delegates were taken for a tour of Paris by water in sightseeing boats, having hostesses to point out the landmarks of the City. Disembarking at a nearby quay, delegates then went to the Hôtel de Ville where they were received and welcomed by the President of the Municipal Council of Paris (Fig. 2).

On the following morning, under the chairmanship of Mr. WIKLUND, the first paper read was that by Prof. J. VAŠÁTKO on the protection of sugar beets and other agricultural products with V-K chalk, while the subsequent paper was that on the influence of silo microflora on the quality of the stored beets by J. ORKOWSKA.

E. ANDERSEN and E. SMED presented their paper on the chemical composition of sugar beet in relation to the effective alkalinity and the sugar loss in molasses, on the basis of the impurity value of CARRUTHERS *et al.* involving K, Na and NH₂ in beet juice. Dr. W. KRÜGER described his work on the relationships between residual lime and the alkalinity ratios of the various factory conditions and different beet material.

The combined effects of sucrose and lime on the solubilization of sugar factory juice flocs, calcium oxalate and carbonate were then discussed by J.

DUBOURG, P. DEVILLERS and P. NAFFA, while Prof. S. ZAGRODZKI discussed the systems of heat economy in sugar factories.

In the afternoon, Dr. J. VAŠÁTKO took the Chair and introduced Dr. H. P. HOFFMANN-WALBECK, who discussed the $KMnO_4$ and BOD_5 values of the regeneration liquors from factory ion exchanger installations. P. DEVILLERS described the use of ion exchangers for adjustment (particularly reduction) of the pH of various sugar products.

In the last series of papers, Dr. J. L. HICKSON described the philosophy behind the latest efforts of the Sugar Research Foundation Inc. in the development of non-food uses of sugar, the economic realities of production costs, possible demand, etc., being considered. Prof. F. SCHNEIDER described the results
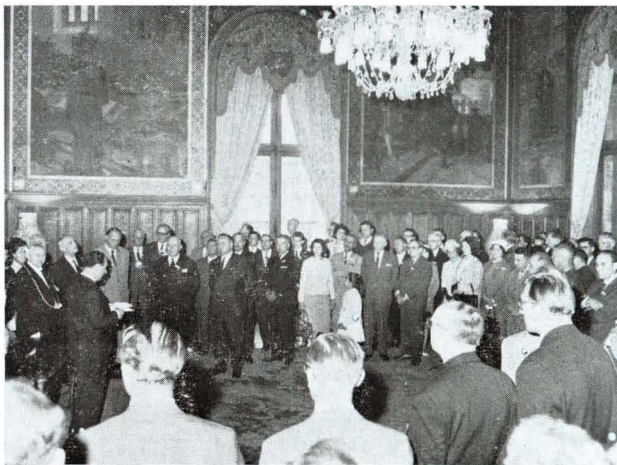
[*Photo*: Hallery]

Fig. 2

achieved by the Braunschweig Institute's programme of preparation of esters, etc., and of possible uses as detergents. The last paper, also from Braunschweig, but by E. REINEFELD, described the partial acylation of sugar with an account of the 6- and then 2,6-disubstitution of the glucose moiety.

Dr. A. CARRUTHERS, the new Chairman of the Scientific Committee, then closed the meeting after thanking Prof. DUBOURG, his assistants who had helped to organize and maintain the smooth flow of the Conference, and also the interpreters whose efforts were much appreciated.

The final event of the Conference was the dinner given by the Syndicat National des Fabricants de Sucre de France to the delegates and wives.

THE VISCOSITY OF MILL SYRUPS

By B. CORTIS-JONES, R. WICKHAM and Miss J. GODDARD

(C.S.R. Research Laboratories, Roseville, N.S.W., Australia.)

ALTHOUGH high viscosities of syrups in sugar factories frequently cause trouble in boiling, the range of viscosities encountered and the substances responsible are incompletely known. Viscosities of syrups from C.S.R. mills were determined throughout the season in 1958 and 1959. The means, expressed as percentages of the viscosity of pure sucrose solution under the same conditions, were as follows:—

A syrups, 1958	185%	(11 mills)
B syrups, 1958	219%	(11 ,,)
B syrups, 1959	248%	(6 ,,)

The lowest viscosity observed was 50% above that of an equivalent sucrose solution. The increase generally must be due to components normally present in mill syrups since most samples were from cane in good condition. The greatest increase in viscosity recorded was associated with deteriorated cane but it was only about twice that found for a normal B-syrup. It was our purpose to identify types of constituents in both normal and abnormal syrups which caused their viscosities to be considerably above those of pure sucrose solutions.

FOSTER, DAVIES and SOCKHILL[1] had separated a fraction from molasses by repeated precipitation with ethanol and further purification by ion exchange methods. Largely polysaccharide, this material represented about 1·4% of the solids, and when added to the extent of 2–3% it doubled the viscosity of molasses or of a synthetic syrup of sucrose, glucose and fructose. The Sugar Research Institute, Mackay[2] reported that removal of suspended solids and of the ethanol-insoluble portion each significantly reduced the viscosity of molasses. The latter fraction was found to consist of polysaccharides, nitrogenous substances and the sulphates and aconitates of potassium and calcium. Other cations and anions increased the viscosity of sucrose solutions to a varied extent.

SUTHERLAND[3] found that high viscosity was associated with the amount of so-called "colloidal material" obtained by precipitation with alcohol and with the amount of polysaccharide contained in this fraction. He showed also that hydrolysis of the polysaccharide from high-viscosity syrups yielded a greater amount of glucose than was obtained from the polysaccharide of low-viscosity syrups. He attributed the difference to the presence of dextran in the former syrups and believed that this was probably responsible for the high viscosities observed.

PRELIMINARY WORK

Survey of Viscosities

Composite samples of *A*-syrup and snap samples of *B*-syrup were obtained weekly from all C.S.R. Co. mills throughout the crushing season in 1958. Snap samples of *B*-syrup were also obtained weekly from a number of mills in 1959. All the syrups were brought to a concentration of 70–73° Brix and their viscosities were determined with a Höppler Rheoviscometer.

Fractions Studied. The fractions studied were:—

(*a*) The sediment obtained by centrifugation after diluting the syrup to 20°Brix (this re-dispersed readily in concentrated sucrose solution).

(b) The macromolecular components obtained as the residue after dialysis of the syrup. (Material precipitated with alcohol was also sometimes taken as representing the macromolecular components.)

(c) The components of low and medium molecular weight obtained in the dialysate from the syrup.

Even with such broad groups as these, no single group had a really big effect on the viscosity of sucrose solution when added in the amount present in the syrup from which it was isolated. The biggest effect was exerted by the macromolecular components —an increase of up to 35% of that shown by the original syrup and generally about 25%. Each of the other groups of impurities had only a minor effect. Only when the macromolecular impurities were added in nearly three times their natural concentration were they found to give a viscosity approaching that of their parent syrup.

The viscosity of aqueous solutions of the crude fractions of macromolecular impurities was determined. The impurity:water ratio in these solutions was deliberately made higher than the corresponding ratio in the original syrups but the viscosities observed were always quite low. For example, one syrup sample had a relative viscosity of 353% at 60°C, and the concentration of the crude macromolecular components in the water present was about 7%. These separated impurities, when dissolved in water to a concentration of 14%, gave a viscosity of only 4·2 cp at 60°C. This is only about six times the viscosity of water at the same temperature. (The same impurities when in their original concentration in a sucrose syrup at 73°Brix gave at 60°C a relative viscosity of

[1] *Proc. 24th Congr. Queensland Soc. Sugar Cane Tech.*, 1957, 223; *I.S.J.*, 1958, **60**, 79.

[2] *Tech. Rpt.*, 1958, (51); *I.S.J.*, 1958, **60**, 367.

[3] *I.S.J.*, 1960, **62**, 185.

145%, equal to an increase of about 31 cp over the viscosity of the pure sucrose solution.) The viscosities of the aqueous solutions of these impurities are low compared with the viscosities of similar solutions of many macromolecular substances, especially polysaccharides.

MAIN INVESTIGATION

The above findings showed that it was necessary to prepare several main groups of impurities and to study the effects of each on the viscosity of sucrose solution, alone and in various combinations. The fractions should be available simultaneously and in sufficient amount for all the required viscosity determinations. Four groups comprised the maximum number which could be handled. Enough of each fraction to measure the viscosity of a total of fifteen mixtures was obtained from 250 g of syrup.

The fractions studied were (1) the material separated by centrifugation after dilution of the syrup to 20° Brix, (2) the neutral polysaccharide fraction, (3) protein and acidic substances removed on a weak base ion exchanger, and (4) salts, amino acids, other sugars, etc., which were obtained together with the sucrose. They were designated for convenience: sediment, polysaccharide, protein and salts respectively.

EXPERIMENTAL

Viscosity.—Viscosity determinations were made with the Rheoviscometer at 60°C. The load applied was chosen so that the time of fall of the sphere was of the order of 30 seconds.

Fractionation.—The fractionation methods used have been previously described[1]. After removal of the sediment at 50°Brix and 20° Brix the material was concentrated to 30°Brix and the total macromolecular material was separated from the salts fraction on a 7·8 cm × 70 cm column of "Sephadex G.25". Two runs were necessary for each sample. The macromolecular fraction was collected first, a small intermediate fraction was discarded, then the main "salts" fraction was collected. The final runnings of the column were discarded. The "protein" was separated from the "polysaccharide" as previously. This was never complete, but each fraction contained the major part of its respective impurity.

Preparation of Mixtures.—About 30 g at 73° Brix was prepared for viscosity determinations, the amount of each fraction added being calculated to give the original concentration, with an allowance of 2·5% for losses during the separation procedure. The "sediment" fraction was kept in the form of a thin slurry and the appropriate amounts of this and of the "polysaccharide" and "protein" fractions were measured by volume. The "salts" fraction was weighed. The required weight of sucrose was added with excess water and the mixture was concentrated under vacuum to approximately 73° Brix. The apparent concentration was determined by measuring the

refractive index, using tables for pure sucrose solution. A nominal figure, in the range 74·5–75·0° Brix was aimed at for all mixtures in which the "salts" fraction was present, or about 73·5° in the absence of this fraction. The concentrations as given by the dry weight was close to 73% in each case. Viscosities were measured as soon as practicable.

The dry weight determination for each mixture was carried out on the day it was prepared. After a final check of the refractive index, the sample was diluted with water and absorbed on a roll of filter paper (2 in × 24 in) and the whole was heated at 70°C for 16–18 hours in a vacuum oven to remove all water. The ratio between the concentration so obtained and that indicated by the final reading of refractive index was used to correct the nominal concentrations obtained from the refractive index at the time of determining viscosity.

The preparation of the solutions of all fifteen mixtures was always done in random order. This was to avoid any systematic bias due to the fact that determinations were spread over three days.

Results.—The reliability of the method was first tested by doing three complete runs on one sample of syrup and two runs on a sample from another mill. Then syrups obtained from both mills at monthly intervals throughout a season were examined.

Results of the replicate tests are shown in Tables 1 and 2. They give the relative viscosities of all mixtures and the mean increases in viscosity expressed as percentages of the increase shown by the syrup (% Total Increase).

Table 1

Viscosities due to Syrup Fractions
(Syrup from N.S.W. Mill, 1959)
Original relative viscosity 295%

| | *Relative Viscosity %* | | | *Increase (% Total* |
Fractions	Run 1	Run 2	Run 3	Mean Increase)
Sed.	114	119	102	112	6
P/s	186	153	153	164	32
Pr	111	112	119	114	7
Salts	127	125	117	123	12
Sed. + P/s	188	165	164	172	39
Sed. + Pr	123	121	123	123	12
Sed. + Salts ..	134	145	121	133	17
P/s + Pr	195	184	180	186	45
P/s + Salts	194	206	—	200	50
Pr + Salts	134	167	152	151	26
Sed. + P/s + Pr	176	191	213	193	49
Sed.+P/s+Salts	225	225	231	227	66
Sed.+Pr+Salts	138	159	153	150	26
P/s+Pr+Salts	238	210	244	231	69
Sed.+P/s+Pr+ Salts	284	244	228	252	79

Sed. = Sediment
P/s = Polysaccharide
Pr = Protein

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[1] CORTIS-JONES: *I.S.J.*, 1962, **64**, 133, 165.

Table 2

Viscosities due to Syrup Fractions
(Syrup from Queensland Mills, 1959)

Original relative viscosity 242%

Fractions	Relative Viscosity %			Increase (% Total
	Run 1	Run 2	Mean	Increase)
Sed.	99	126	112	9
P/s	121	127	124	17
Pr	106	117	111	8
Salts	124	145	134	24
Sed. + P/s	159	152	155	39
Sed. + Pr	137	145	141	29
Sed. + Salts	137	150	143	31
P/s + Pr	142	156	149	34
P/s + Salts	180	178	179	56
Pr + Salts.........	153	159	156	39
Sed. + P/s + Pr	167	176	171	50
Sed. + P/s + Salts ..	204	210	207	75
Sed. + Pr + Salts ..	162	159	160	43
P/s + Pr + Salts ..	179	200	189	63
Sed.+P/s+Pr+Salts	212	198	205	74

Sed. = Sediment
P/s = Polysaccharide
Pr = Protein

Table 3 shows the mean results obtained with syrup samples obtained over the season. They are generally similar to those of Tables 1 and 2.

Table 3

Mean increases in viscosity of monthly samples of B syrup from 2 mills (1961)

Original relative viscosity—NSW 237% Queensland 196%

Fractions	% Total Increase		Increase found less Increase calculated	
	N.S.W.	Q'land	N.S.W.	Q'land
Sed.	22	26	—	—
P/s	22	15	—	—
Pr	10	12	—	—
Salts	12	24	—	—
Sed. + P/s	53	42	9	1
Sed. + Pr	30	38	—2	0
Sed. + Salts	45	48	11	—2
P/s + Pr	41	33	9	6
P/s + Salts	37	45	3	6
Pr + Salts	25	43	3	7
Sed. + P/s + Pr	67	57	13	4
Sed. + P/s + Salts	80	77	24	12
Sed. + Pr + Salts	54	76	10	14
P/s + Pr + Salts	57	75	13	24
Sed. + P/s + Pr + Salts	101	115	35	38

Sed. = Sediment
P/s = Polysaccharide
Pr = Protein

To show which main group of impurities in the "salts" fraction was responsible for the increase in viscosity an additional fractionation step described earlier[4] was used. The "salts" fraction of a sample from Queensland was separated into inorganic salts together with basic and acidic amino acids and sugars together with neutral amino acids. The effect of these two fractions on the viscosity of sucrose solution alone, and with the combined macromolecular fractions is shown in Table 4.

Table 4

Effect of separate "salts" and "sugars" fractions on viscosity of sucrose solution

Fraction	Relative Viscosity %
"Salts"	128
"Sugars"	88
Macro	124
"Salts" + Macro	160
"Sugars" + Macro	109
Total	136

Salts = Basic and acid amino acids and inorganic acids
Sugars = Sugars and neutral amino acids
Macro = Protein + polysaccharide

Table 5

The increment in viscosity on adding one fraction to a "syrup" containing the other three fractions (Mean for all syrups studied)

Increment due to:	Mill	Increment %
Sediment	N.S.W.	20
	Queensland	24
Polysaccharide	N.S.W.	50
	Queensland	33
Protein	N.S.W.	17
	Queensland	17
Salts	N.S.W.	32
	Queensland	39

DISCUSSION

Considering the number of operations involved in the examination of a syrup the replicates are in fair agreement. The error in the experiments of Tables 1 and 2 has been calculated from the differences between the individual results and the mean viscosities for each mixture, expressed as percentages of the latter. The overall mean percentage has been taken to give the average error for each syrup and is 4·7% and 3·8% for the two series of experiments. These figures show that the method can be used with some confidence.

The composite syrup (Table 1) represented a high viscosity. However no one fraction accounted for more than one third of the increase in viscosity shown by the syrup itself, the largest being due to the poly-saccharide material; the effect of the other three fractions was comparatively minor. However, com-binations of all four fractions with sucrose produced a viscosity equal to 85% of that of the syrup.

No fraction from the sample of moderately high viscosity (Table 2) accounted for even one quarter of the increase shown by the sample itself. Again the mixture of all four fractions with sucrose gave a material with a viscosity equal to 85% of that of the syrup.

The 1961 syrups (Table 3) from both mills were all in the low-medium viscosity range and the com-bination of all fractions was found once more to increase the viscosity of sucrose solution to the same level as that of the syrups themselves.

When two or more groups of impurities are together they increase the viscosity of sucrose solutions by at least the sum of their individual effects. Generally the effect of the combination is greater than that, this potentiation being more pronounced when three or four groups of impurities are combined (see Tables 3 and 5). The single experiment of Table 4 indicates

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that it is the mixture of inorganic salts and basic and acidic amino acids which is the fraction of the "salts" fraction responsible for increasing the viscosity of sucrose solution. The remaining impurities (mostly other sugars) have no such effect. Similarly the former fraction increases the effect of the combined polysaccharide and protein fractions.

An extreme case of the effect which fractions with only a small individual influence on viscosity can have in the presence of another fraction, was illustrated during one experiment. In this case (not included in the results listed above) the "Sephadex" column became infected with *Leuconostoc mesenteroides* (identified by culture) and dextran was formed in the "salts" fraction. As is usual with dextran of bacterial origin, this caused enormous viscosity in mixtures containing this fraction. Its mixture with sucrose had a viscosity of over twenty-five times that of a corresponding pure sucrose solution. The other fractions, which were free of dextran, had little effect alone and a very moderate effect in combination. Mixed with the dextran-containing fraction, however, they increased the already high viscosity by several hundred centipoises.

The viscosity of all mill syrups is now seen to be due to the complex interactions of the various impurities with one another and with sucrose. None of the impurities give aqueous solutions with viscosities of more than a few centipoises even in relatively high concentration. The viscosities of water solutions of some (e.g. the inorganic salts) must be much less than those of corresponding solutions of sucrose, but even these have been demonstrated to have a big effect on the viscosity of syrups.

Tables 1–3 show that the fraction of impurities which causes the biggest increase in viscosity is not the same in the material from the two mills concerned. However, in samples drawn from either mill at different times, the one fraction has generally been found to have the biggest effect. These facts alone may not be very significant, but coupled with the fact that the mean viscosities of the two sets of samples from the two mills overlap, they become important. They reinforce the argument arising from the other evidence that all impurities must be considered when studying the viscosity of complex mixtures such as mill syrups. Statistical correlations between viscosity and the content of one impurity group are found from time to time. These may be unsatisfactory as other important factors can be overlooked. By the use and extension of the methods described here a more complete picture of the causes of viscosity in syrups should become available.

ESTIMATION OF SUGARS IN BEET MOLASSES

By A. CARRUTHERS, J. V. DUTTON, J. F. T. OLDFIELD, C. W. ELLIOTT, R. K. HEANEY and H. J. TEAGUE

Paper presented to the 16th Tech. Conf., British Sugar Corp. Ltd., 1963.

PART I

MOLASSES analysis is essential for the efficient operation of the beet sugar factory. At the very minimum it is necessary to have an estimate of the amount of sucrose in molasses in order to complete the sugar balance and assessment of process losses. For this purpose there is no necessity for the estimate of sugar content of molasses to be any more precise than the estimate of total weight of molasses produced, and additionally the calculated sucrose in molasses, expressed as a percentage on beet, need not be more precise than the calculated sugar entering the factory in the beet. Consequently the polarization of the molasses is generally adequate as an estimate of molasses sugar, and indeed the polarization of the molasses may be considered to be the most useful measure in that the factory balance can be obtained as a polarization balance rather than an actual sucrose balance.

To assess the efficiency of molasses exhaustion, however, or to assign reasons for the production of molasses with purities above or below the average,

a more accurate estimate of sucrose in molasses is required. If, for example, two samples of molasses contain identical amounts of sucrose, water and total solids but the concentrations of raffinose (anhydrous) are respectively 0·5 and 2·0 per 100 solids, the polarization of the two samples would differ by about 2·3% and the apparent purities would differ by about 2·8 units, although in fact the samples could be considered to be equally exhausted.

The problem becomes acute in attempting to assess the ultimate exhaustibility of molasses. This is normally assessed by seeding the factory molasses and crystallizing for a period of several days under standard laboratory conditions, as for example in the method devised by GRUT[1]. Before crystallization it is necessary to adjust the molasses samples to a standard water content, so that merely leaving excessive water in the molasses does not apparently lead to the conclusion that the molasses cannot be exhausted to a low level. The water content cannot be adjusted on a basis of total solids in molasses as

[1] *Zeitsch. Zuckerind.*, 1962, **12**, 492.

produced, that is by seeding at a fixed Brix, otherwise the additional water associated with any excess sucrose left in by the factory process would reduce the amount of sucrose which could be crystallized in the laboratory exhaustion. Under these conditions, if the molasses purity was high owing to inefficient factory technique, the results of the laboratory exhaustion would apparently show that the molasses really was difficult to exhaust. The water content must therefore be adjusted relative to some component which does not change during crystallization, for example relative to the non-sucrose solids. Lacking any simple means of determining non-sucrose solids, it is more usual to adjust the water content relative to the apparent non-sucrose solids, i.e. dry substance minus polarization. The apparent non-sucrose solids do not alter as the sugar crystallizes but if the two samples of molasses with different raffinose contents were both at 83·3°Bx, 50% sucrose, and the net polarization of all components except sucrose and raffinose were zero, then the apparent non-sucrose solids would be 22·58% (low raffinose) and 20·25% (high raffinose). The high raffinose sample would consequently be adjusted to contain about one-tenth less water than the low raffinose sample and consequently more sugar would be crystallized in the laboratory exhaustion. The interpretation of the low residual sugar content in the high raffinose sample would depend on how this sugar content was measured. The true sucrose content would falsely suggest that sugar was crystallized more easily from the high raffinose sample; the polarization would be elevated by the high raffinose content but it would be purely fortuitous if this elevation compensated for the low true sucrose due to the low water content.

A practical but accurate means of estimating sucrose in beet molasses is therefore a pre-requisite for estimating either the potential or the actual exhaustion of molasses. At present a direct measure of sucrose in molasses is not possible but a variety of methods are available for deducing the sugar content. None of these methods is perfect and this report describes an investigation of independent procedures for estimating minor carbohydrates so as to provide a basis for selection of practical methods for estimating sugars in beet molasses.

Principal carbohydrates in beet molasses

Most methods for estimating sugar in molasses depend on multiple measurements of polarization, or reducing substances, before and after hydrolysis with acid or with enzymes. Several quite important carbohydrates in beet molasses were not known to exist at the time when the conventional analytical methods were devised and to simplify consideration of the methods, the rotational properties of the principal carbohydrates are summarized below. The optical rotations change slightly with concentration and with pH and the quoted values are not intended to be absolute values under any specific conditions, but have been rounded to illustrate the principles involved.

Sucrose: The specific rotation of sucrose is $+ 66·5°$ and, on hydrolysis with invertase, sucrose is converted into an equimolar mixture of glucose and fructose with a specific rotation, based on weight of original sucrose, of $- 21·4°$. The change in rotation on hydrolysis is therefore a decrease of $1·32°$ for each $1°$ of original sucrose rotation. A rather similar change in rotation occurs on acid hydrolysis but, as the negative rotation of fructose increases with increasing mineral acidity, the change in polarization is greater than with invertase depending upon the hydrolysis conditions.

Raffinose (anhydrous): The raffinose content of beet molasses is generally in the range 0·5 to 2·5 per 100 solids. Raffinose is galactosyl sucrose and has a specific rotation of $+ 123·2°$. Hydrolysis with invertase or acid yields fructose and galactosyl glucose (melibiose) and the specific rotation of the mixture, based on the weight of original raffinose, is $+ 64·2°$. The change in rotation is therefore a decrease of $0·48°$ for each $1°$ of original raffinose rotation. The melibiose can be hydrolysed with melibiase to yield glucose and galactose causing a further decrease of $0·51°$ for each $1°$ of melibiose rotation. This decrease is equivalent to $0·40°$ for each $1°$ of original raffinose polarization.

Galactinol: Galactosyl inositol was discovered in beet molasses and named galactinol by BROWN & SERRO[2]. The concentration in British beet molasses might normally be expected to be in the range 0·1–0·6 per 100 solids but concentrations as high as 0·4 per 100 sugar in Nebraskan beet have been reported[3]. The specific rotation of galactinol is $+ 135·6°$, the compound is not hydrolysed by invertase or Clerget acid, but melibiase hydrolysis yields galactose and inositol with a specific rotation, based on weight of original galactinol, of $+ 38·4°$ equivalent to a decrease of $0·72°$ for each $1°$ of galactinol polarization.

Kestoses: At least three oligosaccharides are known to be formed by recombination of fructose units with sucrose during partial hydrolysis of sucrose by yeast-, mould- or plant-invertase[4,5,6]. These oligosaccharides have been termed kestoses and generally l-kestose and *neo*-kestose predominate in beet, though traces of 6-kestose may be present; in total the kestoses generally range from 0·1 to 0·6 per 100 solids in molasses. The specific rotation of the three kestoses are very similar and all yield two fructose and one glucose molecules on hydrolysis with invertase or acid. The specific rotation changes from $+ 26°$ to $- 47°$ corresponding to a decrease of $2·8°$ for each $1°$ of original kestose polarization.

Glucose and Fructose: Reducing sugars in molasses normally range from 0·2 to 2·0 per 100 solids. Not more than 70% of the reducing sugars consists of

[2] *J. Amer. Chem. Soc.*, 1953, **75**, 1040.
[3] SERRO & BROWN: *Anal. Chem.*, 1954, **26**, 890.
[4] ALBON et al.: *J. Chem. Soc.*, 1953, 24.
[5] GROSS et al.: *J. Chem. Soc.*, 1954, 1727.
[6] BACON & BELL: *J. Chem. Soc.*, 1953, 2528.

glucose and fructose[7], the specific rotations of which are respectively $+52\cdot7°$ and $-92°$. The specific rotation of an ·equimolar mixture of glucose and fructose (invert sugar) is $-20\cdot1°$ but the specific rotation of 2:1 and 1:2 mixtures are respectively $+4\cdot5°$ and $-44\cdot1°$ so the relative proportions of the two hexoses greatly affect the rotation.

Other optically active constituents: There are a vast number of other known optically active carbohydrates in molasses, such as psicose and other hexoses, and the poly-saccharides levan, dextran, araban and galac-ctan. While many of the organic non-sugars are also optically active, the above summary will suffice for consideration of the potential errors in polarimetric analysis of molasses.

Conventional methods for determination of sugars in molasses

It is axiomatic that at least one different measure must be obtained for each constituent, or group of constituents, which are to be considered in molasses. To limit the number of analytical measures, it is necessary either to ignore some of the constituents, or to make measurements which are specific for certain constituents. The latter procedure is to be preferred but the two procedures can be combined. Neither the kestoses nor galactinol were known to exist when the conventional methods of analysis were devised and consequently the methods were then thought to be more specific than is now apparent.

(a) Double-enzyme method. The two-enzyme method of PAINE & BALCH[8] is the most elaborate of the methods employing change of polarization on hydrolysis. In essence this method does not require consideration of the absolute value for molasses polarization at all, and sucrose and raffinose are calculated only from *changes* in polarization. Consequently optically active constituents which remain unchanged during hydrolysis with either enzyme, such as glucose and fructose, do not constitute ·a source of error. The molasses is hydrolysed once with invertase and once with invertase plus melibiase, the sucrose and raffinose being deduced as follows: The difference between the rotations of the two hydrolysed solutions is considered to be due to the hydrolysis of melibiose originating as raffinose; hence the raffinose may be calculated. The difference between the un-hydrolysed and the invertase-hydrolysed polarizations is considered to be due to sucrose plus raffinose and, knowing the raffinose content, the sucrose can be calculated.

Prior to discovery of galactinol and kestose, the chief disadvantages of the method were that the three polarizations could not be carried out on the same solution and so there were some potential errors in preparing the triplicate solutions and also that the difference between polarizations of the two hydrolysed quarter-normal solutions was only about $0\cdot4°ISS$ (400 mm tube) for each 1% raffinose in molasses; this difference was often of the same order as the correction required for 'the optical rotation of the enzymes used for hydrolysis.

Consideration of the specific rotations listed in the previous section, however, shows that 0·4% of galactinol will be determined as 0·53% of melibiose which will in turn be calculated as 0·8% raffinose in molasses. Furthermore, although the galactinol was not affected by invertase, the assumption that an additional 0·8% of·raffinose contributed to the change on invertase hydrolysis will result in falsely lowering the ,calculated sucrose by about 0·5%.

By contrast, the change in rotation due to invertase hydrolysis of kestose would be attributed solely to sucrose, since the hydrolysis products cannot be further changed by melibiase. The kestoses have a low specific rotation but the change in specific rotation on hydrolysis is almost as large as that of sucrose and a concentration of 0·6% kestose in molasses would falsely raise the calculated sucrose content by 0·5%.

Levan is also slowly hydrolysed by invertase to yield fructose alone and each 0·1% levan in molasses would be determined as about 0·06% sucrose. The levan error would only be significant when frost-damaged beet were being processed.

Although the two-enzyme procedure is the best of the polarimetric techniques, yet in addition to the inherent errors of polarization, the galactinol error may yield raffinose values which are excessive by up to 0·8% on molasses, while depending on the kestose: galactinol ratio the sucrose content may be either high or low by as much as 0·5%.

·*(b) Other methods of double polarization.* Since the PAINE & BALCH procedure is time-consuming, and melibiase preparations are not readily available, other hydrolysis procedures, omitting the melibiase in-version, are employed in process control. The molasses is inverted with invertase or acid but, since one change in polarization is inadequate even if all constituents other than sucrose and raffinose are ignored, it is necessary also to make use of the direct polarization as an absolute value. In effect the sucrose and raffinose are deduced by calculating what combination of sucrose and raffinose could together be responsible for the polarization before hydrolysis and also for the change in polarization on hydrolysis.

These methods are therefore subject to errors from two sources: (a) the polarization before hydrolysis is not due to sucrose and raffinose alone, and (b) the change in polarization is not due to sucrose and raffi-nose alone. Source (a) was avoided in the two-enzyme method, while source (b) is common to all methods though the extent of the error depends on the procedure. A net polarization of the components other than sucrose and raffinose of $-1\cdot0$ for a normal solution would, if unchanged during hydrolysis, elevate the sucrose content by about 0·6% and depress the raffinose content by about 0·85%. To attempt to minimise this error, some procedures apply a "cor-rection" to both polarizations to allow for the polari-

[7] CARRUTHERS *et al.*: *Paper presented to the 15th Tech. Conf. British Sugar Corp. Ltd.*, 1962; *I.S.J.*, 1962, **64**, 343.
[8] *Ind. Eng. Chem.*, 1925, **17**, 240.

zation of the reducing substances in molasses. This correction is based on the assumption that the reducing substances consist only of glucose and fructose in equal proportions. Such a correction may not necessarily improve matters as the actual polarization of the reducing material is variable and unknown. Galactinol, moreover, is not hydrolysed by invertase or acid and has a positive specific rotation which is nearly seven times the negative specific rotation attributed to the reducing sugars. It is therefore possible for the net polarization of constituents other than sucrose and raffinose to be positive and, if so, any correction for reducing sugars would increase the analytical errors.

In considering errors under source (b), hydrolysis of kestose and levan will elevate the apparent sucrose and depress the apparent raffinose while an additional source of error can arise in acid hydrolysis owing to effects of acid on the specific rotation of organic non-sugars.

In all the procedures for double or multiple polarization, the potential errors do not lie in the same direction and it is quite possible for the errors to compensate so that at least one of the carbohydrates is correctly estimated in some molasses samples. Since the errors are to some extent compensating, the inclusion of additional refinements in the analytical procedure may not lead to greater accuracy.

Determination of all the optically active constituents in molasses is clearly impracticable and so a choice must be made as to which constituents are to be ignored. This choice cannot be made by measuring the recovery of sucrose or raffinose added to molasses as these carbohydrates may be recovered quantitatively even though the analytical values for the original molasses are incorrect. An examination was therefore made of independent methods for determination of carbohydrates in molasses.

Chromatographic determination of raffinose

The chromatographic determination of raffinose[9] was one of the earliest independent methods for determination of a carbohydrate in molasses which could reasonably be expected to be specific. The procedure has been thoroughly examined by ICUMSA[10] and standard conditions have been recommended for estimation of raffinose in molasses. Whether the raffinose is estimated by visual comparison with standards or by elution followed by photoelectric determination, it is necessary that the raffinose be separated chromatographically from other carbohydrates of which the kestoses are the most likely to present difficulty. Generally no difficulty occurs in separation of raffinose from l-kestose and *neo*-kestose but the mobility of 6-kestose is very similar to that of raffinose. To obviate difficulties due to kestoses, DE WHALLEY[11] has proposed invertase hydrolysis of both the molasses and the standards to convert the raffinose to melibiose and, after chromatographic separation, the raffinose content is estimated by visual comparison of the melibiose spots. This method is also approved by ICUMSA but fortunately the concentration of 6-kestose in beet molasses is normally low and the results for the two procedures are recorded in Table 1.

Table 1
Determination of anhydrous raffinose by direct chromatography and by chromatography after hydrolysis to melibiose

	Raffinose concentration (g/100 g molasses)	
Source of molasses	Direct	After hydrolysis
Felsted	0·8	0·9
Felsted	1·4	1·4
Kidderminster	1·7	1·8
Peterborough	1·4	1·4
Selby	1·4	1·4
Spalding	1·6	1·5
Wissington	1·8	1·8

As the results obtained by the two methods do not differ significantly, the extra time involved in hydrolysis to melibiose is scarcely justifiable.

If raffinose is to be determined photoelectrically after elution from the paper chromatogram, it is desirable that the application should be increased to give reasonable colour yields and to minimize interference from materials extracted from the paper. It was found possible to separate 4 mg of molasses applied as a 20% solution in 2×2 µl applications to 5 spots at regular intervals across a $1\frac{1}{4}$-inch strip of chromatography paper. By marking out nine such strips on a single chromatogram it was possible to obtain four strips for determination each flanked by a marker strip which was sprayed to locate the raffinose band, while still leaving a blank strip at each edge to provide a paper blank. This blank was minimized by pre-washing the papers in water overnight. The chromatograms were irrigated in *n*-propanol:ethyl acetate:water (7:1:2) for 60 hours after which the raffinose bands were cut out and eluted. The eluate was adjusted by weight to 2 ml and the raffinose content was determined with anthrone reagent prepared by the method of FAIRBAIRN[12]. Similar determinations were also carried out using chromatographic separation of melibiose from invertase-hydrolysed molasses. The results are compared with visual estimates of raffinose in Table 2.

Table 2
Comparison of raffinose determination by visual and elution methods

	Anhydrous raffinose (g/100 g molasses)			
	Felsted	Felsted	Kidderminster	Wissington
Raffinose estimated direct				
Visual	0·8	1·4	1·8	1·8
Elution—anthrone	0·89	1·47	1·90	1·83
Raffinose estimated as melibiose				
Visual	0·9	1·4	1·8	1·7
Elution—anthrone	0·85	1·46	1·87	1·74

The quoted values for the elution-anthrone procedure are the means of 8 strip determinations with a scatter about the mean of $\pm 6\%$. The reproducibility of the visual estimate is normally $\pm 0·1$ at a raffinose level of 1·0% and $\pm 0·2$ at a level of 2·0% and from the similarity of the values obtained by the different procedures in Table 2 it is considered that the visual determination without hydrolysis is sufficiently reproducible for a routine determination.

(To be continued)

[9] ALBON & GROSS: *Analyst*, 1952, **77**, 410.
[10] *Proc. 12th Session ICUMSA*, 1958, 90.
[11] *I.S.J.*, 1952, **54**, 158.
[12] *Chem. and Ind.*, 1953, 84.

Exhaustion of final molasses. J. ACOSTA C. *Bol. Azuc. Mex.*, 1962, (161), 22–29.—Samples of Louisiana molasses were analysed and subjected to "cyclone" or extreme exhaustion at 50°C in the presence of powdered sugar for 48 hr, thereafter cooling with agitation to 30°C during 20 hr, maintaining at 30°C for 15 days and gradually reheating to 50°C. Samples of molasses were obtained using a special filter press and re-analysed. A formula was developed for true purity of exhausted molasses: $P = -5.67 \dfrac{\text{impurities}}{\text{water}}$ $+ \dfrac{58.5 \times 0.111}{\text{R.S./ash}}$, R.S. being reducing sugars and ash sulphated ash. Recommendations are made for obtaining maximum exhaustion; these are: boiling to high density (89–90 refractometric solids or 99–100°Bx), use of high speed centrifugals, purging at about 50°C and no higher than 55°C if re-dissolving of crystals is to be avoided, a final strike grain size of 0·25–0·35 mm, use of modern seeding methods and instruments in the pan and a minimum crystallization time of 72 hr.

* * *

Continuous pipe-line defecation with kieselguhr. A. M. BARTOLO. *Proc. 1961 Tech. Session on Bone Char*, 145–156.—A description is given of an automatic system for addition of lime, phosphoric acid and kieselguhr to washed sugar liquor. The flow rate of liquor adjusted to 63°Bx and at 185°F is measured and the desired amount of phosphoric acid and lime added from separate supply tanks to the blow-up tank, a fine control on lime addition being derived, from a pH meter/controller. The liquor flow also governs the addition rate of dry kieselguhr by screw conveyor from its supply bin. The liquor, chemicals and kieselguhr are mixed in the 800 gallon blow-up tank which is provided with automatic level and temperature controls as well as a stirring device. The liquor at pH 7·5 ± 0·1 is filtered on Sweetland pressure filters. Automation has resulted in continuous operation, elimination of human error, labour savings, reduced acid consumption, good pH control with elimination of inversion, and these gains more than offset the 25% rise in kieselguhr consumption.

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Improving a low grade service char with "Synthad". F. W. SCHWER and R. J. BAIRD. *Proc. 1961 Tech. Session on Bone Char*, 207–222.—The adsorbent system at the Philadelphia refinery of the National Sugar Refining Co. includes "Synthad" used as the B or intermediate material while natural bone char was used as the A and C or high and low-grade adsorbents. The C char losses were made up by transferring A char—to the extent of 30% per year—but in spite of this addition of higher quality material,

the C char quality fell as did its performance. This was eventually attributed to attrition of the newer A char added by the harder old material so resulting in its rapid removal as dust, and also to kiln deficiencies which caused uneven and excessive decarbonization and overheating of portions of the char. "Synthad", however, had shown itself resistant to attrition and also to need higher reburning temperatures, so additions of new and service "Synthad" to the C char, as well as some new char, were started, some of the denser C char being discarded. The average annual rate of make-up fell, and performance improved so that it was better than those of the A char and the B "Synthad", as regards colour and ash removal.

* * *

Reaction of oxygen with unkilned bone char at low temperatures (<300°C). F. G. CARPENTER and V. R. DEITZ. *Proc. 1961 Tech. Session on Bone Char*, 237–257.—The reaction of oxygen with unburnt bone char at temperatures below 300°C was studied in a flow system under conditions of continuous mixing and imitate contact between the char and the gas phase. Excellent heat transfer was realized between char particles and the gas flow. The results were interpreted by the relationship $r = ape^{-W/RT}$, r being the rate of oxygen removal, p its partial pressure, T the kiln absolute temperature, R the gas constant, and a and W being constants, the latter the Arrhenius energy which was of the order of 15–20 kcal/mole and depended in a predictable manner on the temperature and amount of oxygen consumed. Both heating and cooling cycles were studied. Three technical procedures are recognised for the decarbonization of bone char; each attempts by a limited oxygen reaction to burn off as much carbonaceous residue as was formed by pyrolysis and thus keep the carbon content of the char constant. The oxidation may proceed (i) with air while heating (ii) with limited oxygen at the highest kilning temperature (current practice in Herreshoff kilns), and (iii) with air cooling (current practice in pipe kilns). Advantages and disadvantages of a decarbonization during the initial heating cycle were discussed. From a practical point of view, the suggested decarbonization of bone char during the heating cycle has the following advantages over conventional practice: (1) control of the amount of "burn-off" is readily achieved by good temperature control, (2) the problem of char ignition in driers is eliminated by the use of good temperature controls, (3) the carbon content of the char tends to be more uniformly distributed throughout the particle, and (4) higher pH of the char liquors result. To be balanced against these are the following disadvantages: (1) slightly inferior calcium removal may be obtained,

and (2) slightly inferior colour removal in the first effluent from those chars which were heavily loaded with low-test on-liquors.

* * *

Ionic interactions with sugar colorant during char filtration. F. G. CARPENTER, D. LARRY and V. R. DEITZ. *Proc. 1961 Tech. Session on Bone Char*, 259–291.—Colouring matter in process cane liquors may be present in molecular or ionic form. Experiments are described in which strong ionic interactions with the ionic form of sugar colouring matter were demonstrated using a column test procedure. The ionic interactions of the colouring material with added calcium chloride or potassium sulphate were followed in some detail, and the results of many measurements were correlated through a quantity termed "excess polyvalent anions", EPA. The EPA, expressed in concentration units, is equal to the total anions less chloride and less calcium (as measured by EDTA titration). A reaction mechanism is proposed to correlate all the known facts, in which it is postulated that the ionic and molecular forms of colouring matter are interconvertible. Part of the mechanism of colour removal is the adsorption of the Ca-colour anion pair and an exchange of other anions for the colouring matter anion. An anion adsorption series is proposed, the following sequence of ions appearing valid for the adsorption process on bone char: $HPO_4^- > CO_3^- > SO_4^- > OA^- > a^{*-}$, where OA^- represents "other anions" (total anions less chloride and less sulphate), and a^{*-} represents anionic colouring matter. An experimental procedure is illustrated in which varying sequences of liquors may be used to provide much more information than can be derived from a single experiment.

* * *

Desorption of calcium and sulphate ions from revivified bone char. H. M. ROOTARE, V. R. DEITZ and F. G. CARPENTER. *Proc. 1961 Tech. Session on Bone Char*, 293–316.—Slurries of revivified char in water, of varying weight ratios, were shaken together at temperatures of 20°, 30°, 40°, 60° and 80°C. A steady state was observed after about 18 hours' contact, and the amount of calcium and sulphate ions then desorbed was found to depend on the slurry density and on the preceding kilning. The data were not in disagreement with the simple Langmuir desorption model, and reasonable values were obtained for the parameters. The capacity of the surface to adsorb sulphate increased because of kilning (at 550°C for one hour in a nitrogen atmosphere), but subsequent contact with atmospheric carbon dioxide between kilning and testing decreased this capacity. The desorption of the calcium ions was definitely greater than that of sulphate, indicating the presence of some other anion. There are indications that the bicarbonate equilibria play an essential rôle in the desorption of calcium salts from bone char.

* * *

Economization of steam consumption in (the) cane sugar factory. B. B. PAUL. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 29–38.—A survey was carried out at Daurala sugar factory of steam requirement of the prime movers, mills, juice heaters, etc., and total consumption was calculated to be 1.0753×10^5 lb/hr or 58·4% on cane. Actual consumption was 64–70% and a number of suggestions for improving steam economy are discussed; these include installation of a vapour line juice heater, a thermo-compressor and preheater for the evaporator, use of vapour bleeding, recirculation of sweet water, lagging of steam and other pipes containing hot fluids. The cost to these items was calculated, together with the savings to be expected.

* * *

Modification of (a) crystallizer's cooling coil. B. B. PAUL. *30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 39–42.—Satisfactory results have been obtained in tests with a modified Fletcher crystallizer in which cold water is fed along a central pipe formed as part of the axis of the stirrer elements. Flexible rubber hose sections lead the cold water into each of the shaft mounted elements, the shaft in this case consisting of the outer pipe, concentric with the cold water pipe, and into which another small bore pipe conducts water from the cooling element. The "used" water then passes along the outer pipe to the discharge. Since the flexible hose seals the connexion between the central pipe and the element, the cold water cannot "short-circuit" and the elements are thus in continuous use. Further, the cooling circuits are the same along the whole length of the crystallizer, ensuring uniformity in the massecuite.

* * *

An off-standard pan boiling and curing scheme as adopted in a double sulphitation factory. S. P. SANYAL. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 49–52.—The capacity was increased and smaller amounts of massecuite % cane and less make-up fuel were needed after adoption of a new boiling-house technique at a double sulphitation factory. Previously, double-cured C sugar was remelted and single-cured B sugar was used as seed for the A massecuite, while B and C massecuites were grained on syrup. In the new system, double-cured C sugar was used as seed for A massecuite while single-cured B sugar, mingled with A molasses, is mixed with A massecuite before curing.

* * *

Use of flocculating agents during sugar cane juice clarification. III. Use of "Separan AP-30" in khandsari sugar manufacture. S. BOSE, K. C. GUPTA, S. MUKHERJEE and A. N. SRIVASTAVA. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 67–77.—Addition of "Separan AP-30" in water solution to juice before settling increased the rate of settling, gave clearer juice and reduced mud volume, the optimum dosage being 2 p.p.m.

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Criteria of gur grades in Uttar Pradesh. K. KAR. C. P. GUPTA and M. K. SRIVASTAVA. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 103–110.—Physical and chemical examination of gur samples from 10 districts showed that, for consumption purposes, quality as determined by colour, sweetness

and flavour corresponding adequately to chemical quality, as judged by sucrose content. Chemical evaluation is necessary where the gur is to be refined.

* * *

Bagasse saving in (the) cane sugar factory. B. B. PAUL. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 111–118.—An evaluation is made of the heat and bagasse savings which can be achieved by drying bagasse from 50% to 40% moisture using flue gas; the drier bagasse having a higher calorific value more than makes up for the smaller quantity to be burnt.

* * *

Chromite as a surface coating material to ward off corrosion in bagasse furnaces. P. C. SEN. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 119–122.— Bagasse ash melts in horse-shoe furnaces using hot air draught and the glass formed attacks the furnace brickwork. Experiments show that the attack can be prevented by a lining of chromite (30–45% Cr_2O_3, 15–33% Al_2O_3, 11–17% SiO_2, 3–6% FeO) applied (as a stiff paste, mixed with molasses) to the brickwork, the life of which is thereby prolonged considerably.

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Examination of (the) activated sludge process for the treatment of sugar factory effluents. J. P. SHUKLA and B. D. KAPOOR. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 123–127.—Examination showed that it was possible to apply the activated sludge technique for pre-treatment of sugar factory effluent so as to reduce its pollution load to the point where it could be sent to high-rate trickling filters without exceeding their capacity. A sludge-effluent ratio of 1:4 proved satisfactory, with aeration for 2–4 hr, while addition of N ($1/17 \times$ BOD) and P ($1/90 \times$ BOD) as nutrients was beneficial.

* * *

Improvements in carbonatation process for production of better keeping quality sugars. S. N. G. RAO, N. A. RAMAIAH and B. I. NEMADE. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 151–153.— Development of colour in stored white sugar is attributed to slow caramelization, particularly catalysed by the K_2CO_3 and K_2SO_3 present after carbonatation and sulphitation, respectively. The colour formation is greater with carbonatation, which fact is attributed to the higher solubility of K_2CO_3 and its stronger alkalinity. Sugars produced later in the season develop colour quicker and have higher K_2CO_3 content. Sugar stored nearer the roof of the godown develop more colour, indicating the influence of higher temperature. It is suggested that the colour formation of carbonatation sugars might be reduced by sulphitation of syrup to pH 5 instead of 5·6, when the CO_3 content is reduced by approximately 40%. The importance of seed quality is emphasized.

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A new damp-proof material for use in sugar godowns— "Insproof". N. A. RAMAIAH. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 199–202.—See *I.S.J.,* 1963, **65**, 116.

Studies on the possible occurrence of inversion in evaporation of thin juices sulphited to different pH values. S. K. D. AGARWAL and B. I. NEMADE. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 155–160.—Laboratory tests using juice sulphited to pH 6 and pH 7 and boiled under reflux for 3 hours, and factory trials in which juice sulphited to pH 6 and 7 were sampled after evaporation, showed that no drop in purity occurred. Hence no inversion took place under such conditions.

* * *

Composition of exhausted molasses. V. J. MEHTA and R. K. KULKARNI. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 161–168.—Analyses of molasses from Brix, pol, sucrose, reducing sugars, ash, nitrogen, gums and organic non-sugars, were made using samples corresponding to each month of the 1958/59, 1959/60 and 1960/61 seasons. The results are tabulated and given in graph form. No correlation was found between exhaustibility and any single factor.

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Influence of recirculation of molasses on its formation and exhaustion. D. J. YANDE, G. B. KULKARNI and B. V. PAGE. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 169–180.—Examination of the effects on sugar quality of boiling C light molasses in various systems is reported, and it is concluded that while recirculation of molasses cannot be completely avoided, it should be minimized because it results in sugar of higher colour and poorer purity and keeping quality. Molasses colour and viscosity are also higher. High purity final molasses, e.g. from a viscous massecuite, should not be reboiled.

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Deterioration of sugar in carbonatation factories. D. R. PARASHAR. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 181–193.—Sugars stored in godowns were analysed and examined at intervals. The results are tabulated and indicate that in spite of precautions during manufacture, a certain amount of colour formation is to be expected especially in hot weather. Bags in the top layers develop colour quicker and the deterioration continues with time. Smaller crystals develop colour quicker than larger crystals. The temperature effect is greater than that of humidity while no direct relationship is apparent between colour formation and pH, pol or sugar moisture. As colour increases, the SO_2 content of the sugar crystals decreases, a phenomenon which requires further investigation.

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Fondant seeding for boiling final massecuite. T. C. JHINGAN and S. P. RATHI. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India,* 1962, 195–197.—An account is given of the preparation and use of a fondant slurry for seeding of massecuites whereby to achieve more uniform massecuites, better and quicker purging, lower molasses purity and thus higher crushing rates.

BEET FACTORY NOTES

Theory of the operation of diffusers and its applications. P. M. SILIN. *Gaz. Cukr.*, 1963, **65**, 3–5.—See *I.S.J.*, 1962, **64**, 371.

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The influence of beet tissue quality on the value of the diffusion coefficient. S. ZAGRODZKI and J. KUBIAK. *Gaz. Cukr.*, 1963, **65**, 8–9.—See *I.S.J.*, 1963, **65**, 28.

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The economical limit of extraction from cossettes. S. ZAGRODZKI and S. M. ZAGRODZKI. *Gaz. Cukr.*, 1963, **65**, 9–14.—See *I.S.J.*, 1963, **65**, 21.

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Preliminary tests on the use of forced ventilation for sugar beet storage. J. ANTKOWIAK. *Gaz. Cukr.*, 1963, **65**, 20–22.—A 7 kW fan was included in a forced ventilation system applied to a pile of 420 metric tons of beet over a period of 64 days. This delivered 57·1 cu.m. of air per hr per ton of beet and resulted in a reduction in sugar losses from an average of 0·121% per day (7·759% over the whole period) to 0·074% per day (4·798%). Other tabulated data show the extent of rotting in the control and ventilated piles and the trends of temperatures during the storage period.

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Measuring and control equipment in East German sugar factories. H.-J. STOCK. *Zuckererzeugung*, 1963, **7**, 2–8, 27.—Information is given on various pieces of equipment, mainly of East German manufacture, used for process measurement and regulation in various East German sugar factories. Some details of these processes are also given.

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Accepting sugar beet according to quality indexes. E. SOMMER. *Zuckererzeugung*, 1963, **7**, 16–17.—It is suggested that the beet quality be assessed by determining the refractometric Brix and multiplying by a factor. This factor would be determined for each year by multiplying the purity by the juice factor (ratio of beet digestion:juice pol) and in the examples tabulated is about 0·78. The quality values so determined for different beet varieties from different areas at various harvesting periods agreed closely with the sugar content determined polarimetrically and further tests are to be carried out to determine the applicability of the method.

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Mechanical vapour compression in sugar factories. F. BONACKER. *Zuckererzeugung*, 1963, **7**, 19–21.—The article by VERNOIS[1] is referred to and particularly the steam consumption figures of 28–36 kg/100 kg of beet for white sugar factories claimed to be obtained in French and Belgian factories while the lowest obtainable in East German factories is 55–65 kg/100 kg.

The fundamentals of automatic control techniques for process engineers. K. H. FASOL. *Zucker*, 1963, **16**, 37–42, 61–67.—The theory of automatic control is outlined with mention of the various forms (proportional, integral, derivative and combinations of these) and various devices available commercially are described with their operating characteristics.

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Continuous defeco-saturation of beet juices. J. DOBRZYCKI. *Przemysl Spozywczy*, 1962, **16**, 443–445; through *S.I.A.*, 1962, **24**, Abs. 994.—A few variants of the process of simultaneous liming and carbonatation have been studied and compared with the classical method of liming followed by countercurrent saturation. Experiments with progressively pre-defecated beet juice showed that continuously defeco-saturated juice filtered faster but was more highly coloured than juice treated by the classical method. Continuous defeco-saturation to a final pH of <9 or 11, with vigorous mixing, avoids the intermediate alkalinity range (0·15–0·3% CaO) in which viscous "sucrocarbonates" are formed. Continuously defeco-saturated juices are thus less likely to become supersaturated. The precipitate obtained by countercurrent saturation had a higher CaO content to which is ascribed its greater adsorbing capacity for colour, since over-saturation led to a desorption of colour. These views were confirmed by experiments with sucrose solutions. Experiments with juices containing added invert sugar (similar to juices from decaying beet) showed that with 0·25% or more of invert sugar, the juices treated by continuous defeco-saturation were lighter in colour than those obtained by the classical method, presumably owing to the absence of a hot main defecation. A mathematical analysis of the effects of circulation on residence time and particle size distribution was carried out, and differential equations governing flow in smaller vessels in series were calculated. Three guiding principles were derived from the work: a first stage of over-saturation at pH 9 improves the filtration rate; the carrying out of a second stage at pH 10–11 eliminates the effects of over-saturation (high colour and lime salts content); the installation of several defeco-saturation tanks in series improves the uniformity of flow and granulation.

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Bulk sugar storage—Weibull silo. A. WOODS. *J. Amer. Soc. Sugar Beet Tech.*, 1962, **12**, 135–140.—An account is given of the Weibull silo installed by Union Sugar Divn., Consolidated Foods Corp., at Betteravia, California, where humidity is extremely variable—with changes from 40 to 100% in 6 hours on occasions. The steel shell is 116 ft in diameter and 82 ft high at the eaves, with an 11-ft dia. tower in the centre[2]. It holds 20,000 tons and is provided

[1] *I.S.J.*, 1963, **65**, 148.
[2] *Cf. I.S.J.*, 1954, **56**, 343.

with a 10,000 c.f.m. circulatory air system, to ensure constant temperature and humidity. The silo has provided economical bulk handling while the sugar quality has not been reduced.

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ISU research on integrated plant. ANON. *Sugar y Azúcar*, 1963, **68**, (2), 22, 34.—Brief mention is made of a research project at Iowa State University for the use of a single plant for sugar diffusion from beets and solvent extraction of soya bean oil at different periods of the year.

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Decalcification of sugar liquors using synthetic resins. Situation following the 1961 season. G. A. PAPARELLE. *Mater. Plast.*, 1962, **28**, 923–927; through *J. Sci. Food Agric. Abs.*, 1963, **14**, *i*–86.—The use of a styrene-divinylbenzene resin in removal of cations of Ca, Mg, Na and K from sugar liquors is described. The results of 4 years' plant experience are given in some detail. The effects of granular size of resin, reduction of NaCl consumption, increase in flow velocity, and other attempts to achieve maximum plant efficiency are discussed.

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The importance of selecting optimum juice purification conditions and a massecuite crystallizing method. D. V. GORBAN'. *Sakhar. Prom.*, 1963, (2), 11–14. Molasses sugar contents higher than the norms at a number of Soviet factories are attributed to non-optimum juice purification and inefficient sugar house work. Details are given of the schemes used at Lokhvitsk and Chupakhovsk factories; at the former, while the non-sugars content in the 2nd carbonatation juice fell from 1·542 kg/100 kg beet in 1953–57 to 1·434 kg in 1958–61, the molasses sugar rose because of inadequate exhaustion in the crystallizers and the purity difference between this and "standard" molasses being almost 300%, higher than in 1953–57, while the actual Brix was 1·8% lower than that of the "standard" molasses. This is attributed to a reduced 1st product sugar yield which results in an increased quantity of 2nd massecuite and curtailing of the crystallization process. The results for Chupakhovsk, processing beet of the same quality as the other factory but using older equipment, show lower non-sugars contents in the 2nd carbonatation juice and a lower molasses sugar, with a higher 1st product yield.

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Molasses studies. O. F. GROMOVAYA and A. I. TATARENKO. *Sakhar. Prom.*, 1963, (2), 19–22.— Analyses of molasses from 10 Soviet sugar factories obtained during the latter halves of the years from 1954 to 1961 inclusive are discussed and the details tabulated. The average molasses sugar content was 2·05% on weight of beet, with a molasses purity of 62·34 compared with "standard" molasses purity of 59·3. Reasons for the higher molasses purity are given, including inefficient massecuite cooling in the crystallizers and failure to maintain optimum Brix.

The invert content of the molasses is also discussed. It is also pointed out that excess lime usage is unjustified when the beet are healthy and merely increases the non-sugars passing into the juice with the excess lime, without reducing the molasses purity.

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Technico-economic characteristics of automation of the individual sections at Ust'-Labinsk sugar factory[3]. A. A. SOLLOGUB. *Sakhar. Prom.*, 1963, (2), 30–34.— The processes for which automation has already been introduced include beet washing, diffusion, carbonatation, juice heating, evaporation, pan boiling and centrifuging, pulp drying and power house steam production. In 1961/62 personnel were cut by 32, steam consumption was reduced by 4·11% on weight of beet, the slicing capacity raised by 60 metric tons per day and the yield of increased purity sugar raised by 0·59% on the weight of beet.

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Automatic density meter for milk-of-lime. L. Z. AMLINSKII, M. M. VAKHUTINSKII, G. YA. GAMAZENKOV and G. M. KOVAL'. *Sakhar. Prom.*, 1963, (2), 37–39.—The device[4] incorporates a float in a conical-bottomed chamber to which the milk-of-lime is admitted tangentially to permit optimum mixing and prevent deposition of sand. Beneath the float is a bellows filled with a volatile liquid whereby any change in temperature resulting in a change in milk-of-lime density is automatically compensated. The float is connected by a system of levers to an induction actuator which acts on the recording/measuring device when the float is displaced. Tests have shown less than ± 0·01 g/c.c. difference between the values given by the meter and a control aerometer over a period of 24 hr. Experiments are to be conducted on syrup Brix determination for exaporator control.

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Problems of molasses exhaustion. K. WAGNEROWSKI, D. DABROWSKA and C. DABROWSKI. *Zeitsch. Zucker-ind.*, 1962, **87**, 664–671.—See *I.S.J.*, 1962, **64**, 115, 146.

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First sugar factory in Tunisia. M. R. BULL. *Sugar y Azúcar*, 1962, **57**, (12), 68–69.—An account is given of the establishment of a beet sugar plant at Béja and some of its equipment.

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Heat economy of sugar factories. A. P. PONOMARENKO. *Sakhar. Prom.*, 1963, (1), 25–38.—The article by VAISMAN[5] is criticized, particularly the reasons given for over-consumption of steam in evaporators. These factors are examined in detail. Inefficient heat usage in Soviet sugar factories is attributed to the following of certain official instructions which are based on erroneous assumptions.

[3] *Cf. I.S.J.*, 1963, **65**, 119.
[4] USSR Patent 147838.
[5] *I.S.J.*, 1962, **64**, 113.

Rationalization of heat usage and improving heat schemes for beet sugar production. S. I. LIBOV. *Sakhar. Prom.*, 1963, (2), 39–42.—Details are given of a scheme developed for sugar factories in which condensate is used to provide heat in the raw juice heaters, the heat from the discard alkali in the saccharate process is used for the black'alkali, and in which the vapour from the 1st evaporator effect is thermocompressed. Certain recommendations are offered whereby the steam consumption may be reduced to 42–43% on weight of beet (without molasses separation).

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The fundamentals of modern juice purification in Hungary. K. VUKOV. *Cukoripar*, 1963, **16**, 1–5. See *I.S.J.*, 1963, **65**, 22.

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The effect of the cooling rate and viscosity of afterproduct massecuite on molasses exhaustion. K. WAGNEROWSKI, D. DABROWSKA and C. DABROWSKI. *Cukoripar*, 1963, **16**, 5–7.—See *I.S.J.*, 1963, **65**, 23.

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Knife grinding at Sarkad sugar factory. F. TURI. *Cukoripar*, 1963, **16**, 12–14.—The methods and equipment used at this Hungarian factory for sharpening beet knives are described with diagrams.

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Improvement of the separation of the solid phase from suspensions in beet sugar manufacture by means of high-molecular flocculants. YU. D. GOLOVNYAK, A. K. KARTASHOV and O. D. KURILENKO. *Izv. Vysshikh Ucheb. Zaved.*, 1962, (5), 78–83; through *S.I.A.*, 1963, **65**, Abs. 14.—Small quantities of sodium polymethacrylate (PMN) or polyacrylamide (PAA) were added to 1st and 2nd carbonatation juices and the effects on the sedimentation characteristics are reported with tables. Other experiments were made with flume waters and with model systems of $CaCO_3$, sucrose and pectin. The 1st carbonatation juice was treated with 10 p.p.m. of PMN or PAA. The clarity of the decantate obtained with hydrolysed PAA (treated with 20% of oleic acid and 10% of NaOH) was much better than that of normal PAA-treated decantate. The optimum dose for treatment of 2nd carbonatation juice was 5 p.p.m. Hydrolysed PAA gave the best decanted juice clarity, whereas the clarity of PMN-treated juice was worse than that of untreated juice. The decantate clarity was also improved by adding small amounts of trisodium phosphate. PAA (1 p.p.m.) was the most effective flocculant for flume waters, especially in the presence of approximately 100 p.p.m. of CaO or aluminium sulphate. Pectin was as effective as PMN as a flocculant in the model systems.

pH measurement in sugar factories. F. SIEFERT. *Regelungstech. Praxis*, 1962, **4**, (1), 18–20; through *S.I.A.*, 1963, **65**, Abs. 47.—The use of pH recorder-controller instruments, with glass electrodes, for control of diffusion, liming and saturation in beet sugar manufacture is described, with diagrams and illustrations. The application of automatic electrode cleaning devices is particularly discussed. The reference electrode can be put in a special flow vessel with a KCl solution reservoir.

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(A contribution) to the technique of determination of the adhesion coefficient of the particles of suspensions. R. KOHN. *Chem. Zvesti*, 1962, **16**, 645–659; through *S.I.A.*, 1963, **65**, Abs. 51.—An attempt was made to apply the method of KURGAEV[6] to the following suspensions: progressively pre-defecated beet juice, 1st saturation juice, milk-of-lime, and a suspension of $CaCO_3$ (carbonatated milk-of-lime) in a 15°Brix sucrose solution with added sodium polymethacrylate. The rates of sedimentation and the final mud volumes were determined for suspensions of varying height (5–30 cm). The method is inapplicable since the particles showed only light compressibility at these low pressures.

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Examination of some local resistances in a pipeline during final molasses flow. Z. S. SHLIPCHENKO and G. E. RUDENKO-GRITSYUK. *Trudy Kiev. Tekhnol. Inst. Pishch. Prom.*, 1962, **25**, 36–41.—The coefficients of local resistances to flow in a U-bend and to flow round a 90° bend were determined at low Reynolds' numbers (1–5000) using a special system incorporating differential manometers. The values for the two resistances are given in graph form as functions of the Reynolds' number and empirical equations are presented. The results are compared with those given in the literature. The studies cover the first two zones of the five into which FRENKEL[7] divides the relationship between ζ (resistance) and Reynolds' number. The relationship is expressed by $\xi = A/Re$, where A is a dimensionless constant describing the geometry of the resistance, ξ *vs.* Re being expressed as a straight line up to $Re = 10$, with increasing deviation above this value until constancy is attained at $Re > 100$. In the first zone, the loss of specific energy with liquid flow is proportional to the speed and volume, while in the second zone, laminar flow is broken by the local resistances. Continuation of the investigations is advocated, extending the range to the intermediate zone, particularly with the 90° bend separated from the U-bend in order to study the mutual effects of two slightly separated local resistances.

[6] *Kolloidnyi Zhurn.*, 1957, **19**, 73.
[7] *Hydraulics (Gosenergoizdat.)*, 1956.

Raw sugar solubility. IV. New solubility tables. G. VAVRINECZ. *Cukoripar*, 1962, **15**, 327–332.— The solubility data of various authors have been used for mathematical statistical calculations from which a formula has been developed of probable error $+ 0.049\%$ (0·9992 correlation index). The formula takes the form: $p = 64.447 + 0.08222\,t + 0.0016169\,t^2 - 0.000001558\,t^3 - 0.0000000463\,t^4$, where $p =$ raw sugar weight $\%$ and $t =$ temperature in °C. A table of calculated values for solubility and molar fractions of the saturated solutions is given for moisture-free, monoclinic, macrocrystalline raw sugar in pure water at -13°C to 100°C. Graphs are also presented showing the scatter and probable error of the basic data used compared with the new values, the effect of the calculation method on the accuracy of the formula (difference between measured and calculated values) and the difference between experimental values of various individual authors and the calculated values.

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Inorganic constituents of sugars and sugar products. R. SAUNIER. *Sucr. Franç.*, 1963, **104**, 1–4.—This is the Referee's report on Subject 25 to the 13th Session of ICUMSA and contains certain recommendations as to methods for determining lead, iron, chlorine, and SO_2. Lead in low-product sugar liquors is determined by the "wet ashing" method with the addition of sodium hexametaphosphate and hydroxylamine hydrochloride. Iron in white sugar is determined colorimetrically with 0·25% aqueous orthophenanthroline using ascorbic acid for reduction. Chlorine is determined by Mohr's method (titration of the Cl^- with $AgNO_3$ using potassium chromate as indicator) or by that of VOLHARD (precipitation of the Cl^- by $AgNO_3$ in the presence of nitric acid, followed by back-titration with KCNS) where the liquors are clear or only slightly coloured; potentiometric titration is to be studied in the case of coloured solutions. SO_2 in white sugar is determined by the method already approved by the 12th Session[1] while alkalis and alkaline earths are determined in molasses by flame photometry.

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Effect of various sugars on browning. Y. POMERANZ, J. A. JOHNSON and J. A. SHELLENBERGER. *J. Food Sci.*, 1962, **27**, 350–354; through *S.I.A.*, 1962, **24**, Abs. 942.—The absorbances at 278 and 500 mμ of solutions of 20 different sugars were determined after heating for 20 min at 114°C. The solutions were buffered at five pH values between 4·6 and 8·9 and contained added glycine or lysine, in addition to a control series without amino acid. The results are fully tabulated. Sucrose, raffinose and melezitose did not brown significantly except in the presence of lysine, when absorbance at 278 mμ (but not 500 mμ) was noted.

New systems for the paper chromatographic separation of carbohydrates. F. SCHEFFER and R. KICKUTH. *Z. Anal. Chem.*, 1962, **191**, 116–121; through *S.I.A.*, 1962, **24**, Abs. 929.—The system dioxane:water: sodium acetate gives highly effective separation of 17 sugars (disaccharides, hexoses, pentoses and deoxy-sugars). A curved filter paper is recommended. R_f values are tabulated for the system and for three other less effective systems (butanol:water:acetic acid, collidine:water, and phenol:water:1% NH_3 + HCN). Dioxane-water mixtures form two liquid phases in the presence of salts.

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A new modification for the separation of sugars by paper chromatography. W. G. JAFFE. *Acta Cient. Venezolana*, 1961, **12**, 135–136; through *S.I.A.*, 1962, **24**, Abs. 931.—A mixture of methylethylketone (10 parts), acetone (4 parts) and water (1 part) is recommended as the solvent on account of its volatility and freedom from objectionable odour. The R_f values of sucrose and fructose relative to glucose are 0·25 and 1·9 respectively. Values for 17 other sugars, polyols, etc., are given. The spots are revealed by the $AgNO_3$ technique of TREVELYAN et al.[2], with substitution of the following procedure for the final spraying with NaOH in aqueous ethanol: the dried chromatogram is placed in a dish containing a mixture of 40% aqueous NaOH (5 parts) and methanol (95 parts) and is transferred after 3–5 min to another dish containing 5% $Na_2S_2O_3$, after which the paper is washed for ½ hr and dried. Stable dark spots are obtained which permit the detection of 1 μg of glucose or fructose or 40 μg of sucrose.

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The mechanical properties of the sugar beet root. K. VUKOV. *Proc. XIth Session C.I.T.S.*, 1960, 291–305. See *I.S.J.*, 1961, **63**, 214.

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Determination of volatile fatty acids in sugar and sugar solutions. A. OKUDA. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1962, **11**, 38–43.—Volatile fatty acids, which are produced by bacterial infection and give sugar products a disagreeable odour, were detected by steam distilling the sugar solutions, neutralizing the steam-distillates, concentrating *in vacuo* and examining by paper chromatography. Acetic and butyric acids were identified by this means. Six pure volatile fatty acids were steam-distilled and successive 100-ml portions of each distillate were titrated with N/50 NaOH solution. For acetic acid, a linear relationship was established between the

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[1] *Proceedings 12th Session ICUMSA*, p.106.
[2] *I.S.J.*, 1951, **53**, 25.

distillation ratio (volume of N/50 NaOH required for distillate neutralization:volume of N/50 NaOH required to neutralize the total amount of volatile acid) and the volume of distillate after the first 200 ml had been distilled. Consequently, the total amount of acid present in samples (in terms of acetic acid) may thus be calculated by applying the appropriate factor to the volume of N/50 NaOH required to neutralize the first 200 ml of the steam-distillate. It was found that the disagreeable odour occurs when raw sugar and fine liquor contain more than 0·04% and 0·016% volatile fatty acid respectively.

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Studies on chromatographic determination of amino acids in sugar beet pressed juice using ion exchanger columns of "Amberlite IR-120". K. HARADA and H. TAMIYA. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1962, **11,** 44–53.—The column chromatographic method of MOORE *et al.*[3] was used to determine the amino acids in clarified beet press-juice. Two "Amberlite IR-120" exchanger columns were used and some modifications were made to the procedure to eliminate difficulties caused mainly by the amides (asparagine and glutamine) and by γ-amino butyric acid; the amides emerged from the column unseparated and accompanied by threonine and serine at a single mixed peak of pH 3·25 of the buffer eluant. The γ-amino butyric acid emerged late when this followed tyrosine separation with a buffer pH of 4·25. The contents of the mixed peak were resolved by hydrolysing the amides to amino acids with HCl, while the γ-amino butyric acid emergence was improved by using a buffer of pH 5·28 for elution after the ·tyrosine had emerged. By the modified procedure the following amino acids were identified and estimated: aspartic acid, asparagine, threonine, serine, glutamic acid, glutamine, glycine, alanine, ?aline, *iso*leucine, leucine, tyrosine and γ-amino butyric acid on the 150-cm column and tryptophane, lysine and arginine on the 15-cm column.

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New whiteness determination method and control method for colour of white sugars. H. OIKAWA. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1962, **11,** 54–62.—A method for determining the colour and whiteness of white sugars is described which is based on the reflectance values at 450 mμ and 560 mμ. The A.C.D. factor is introduced [Achromatic Colour Degree = 100 (reflectance at 450 mμ/reflectance at 560 mμ)] to indicate the extent to which the degree of saturation of white sugar approaches the achromatic colour line, when the two reflectances are equal. A high correlation has been established between A.C.D. and the visual grading of white sugars. Tests carried out using a photoreflectometer gave rather more accurate values than did a spectrophotometer since the reflectometer can project a wide beam and makes use of a larger surface of the crystal sugar sample. A chart is presented with the R.C.V. (Reflectance Colour Value) and A.C.D. as opposing ordinates. This may be used to judge aspects of the colour of a white sugar by plotting the two values and establishing the positions relative to limit lines.

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The floc forming properties and saponin of beet sugars. T. SHIGA. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1962, **11,** 80–106.—A review is given with 44 references to the literature.

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Simplified nomogram of high precision for determination of the specific heat of sugar solutions. E. M. DEMARET. *Sucr. Belge,* 1963, **82,** 161–173.—The specific heat is calculated on the basis of the formula of CAMPBELL MACDONALD & RODGERS[4], i.e. $C = W - \dfrac{Bx}{100}[0·65 - 0·0018\ t + 0·0011\ (100 - P)]$ where $C =$ specific heat at temperature t, $W =$ specific heat of water at temperature t, Bx = Bx density of solution, and $P =$ purity. The positive terms are collected together and values plotted as ordinates against Brix as abscissa. This gives a series of lines corresponding to different temperatures. The negative terms are similarly plotted for increasing Brix and a series of lines plotted corresponding to different purities. The difference in ordinate between the appropriate lines for temperature and purity gives the value of C. The nomogram is available either as a wall chart or series of 5 sheets covering 20°Bx ranges.

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Determination of the total sugar content in Cuban molasses. W. JÄSCHKE. *Zuckererzeugung,* 1962, **6,** 323–324.—Herzfeld's well-known method of determining the total sugar content in sugar products containing large quantities of invert products has been modified for application to Cuban molasses. In this, the molasses is inverted with HCl and an appropriate part of the invert sugar oxidized with Fehling's solution (Soxhlet modification). The residual non-reduced cupric ion is then determined with a 0·05M solution of a chelating agent ("Chelaplex III"). The relationship between the total sugar and the chelating compound is expressed by an empirical formula: % total sugar $= b(a - V)$, where a and b are constants and $V =$ quantity of 0·05M "Chelaplex III" used (ml). The accuracy is to within + 0·25% total sugar.

[3] *Anal. Chem.,* 1958, **30,** 1185–1190.
[4] *I.S.J.,* 1947, **49,** 205.

Variation in the colour of white sugar when raw cane sugar is added to syrup. I. F. ZELIKMAN and D. M. LEIBOVICH. *Sakhar. Prom.*, 1963, (1), 20–23.— Differences in the surface activity of colour bodies in various products are discussed. Laboratory tests were carried out to determine the effect of cane raw sugar added to beet massecuite on the colour of the resultant white sugar. The unaffined raw sugar (10, 20 and 30% on sugar in massecuite) was added to 1st product massecuite or to an artificial massecuite of white sugar and green syrup. The concentration of the resultant solution was such that at the test temperature some of the crystals remained undissolved. The mixture was mingled for 2 hr at 75—78°C, then cooled to 30°C at a cooling rate of 3°C per 15 min. After curing and drying, a 33°Bx solution of the sugar was made up and its optical density measured using a photocolorimeter with a blue filter. White sugar colour is affected both by the proportion and quality of the raw sugar as well as by the quality of the basic product itself. Adding affined raw sugar to a massecuite of 90 purity may reduce the white sugar colour. Affination of the raw sugar is considered to remove a considerable portion of the surface-active non-sugars.

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Complex organic non-sugars in the refining process. L. F. MARTIN. *Proc. 1961 Tech. Session on Bone Char*, 3–24.—A summary of the literature on the complex organic sugars of cane juice is presented; these represent 3–4% of raw juice solids and 30–40% of molasses solids. Five groups (protein, starch, gums, wax/lipids and molasses polymers) are discussed; these may be determined with varying degrees of accuracy but still do not account for a third of the molasses solids and a significant fraction of the juice and syrup non-sugars.

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An ionic constituent survey in the sugar refining process. W. L. REED, W. A. BEMIS and J. V. CONGDON. *Proc. 1961 Tech. Session on Bone Char*, 37–65.—Detailed analyses for inorganic and other constituents were made during one month of 1961 at Revere sugar refinery. These included refractometric Brix, invert, sulphated ash (with 10% correction), purity, calcium, magnesium, sulphate, chloride, total cations and total anions, and, for the overall process, were made on samples of raw sugar, granulated, soft sugar, No. 4 syrup, commercial liquor, barrel syrup, and blackstrap molasses. The data were brought to a standard of microequivalents per gram of sugar solids on melt, and a balance calculated, including losses. In the examination of the affination process, analyses were made on raw sugar, the centrifugal washed sugar, wash syrup, clarifier feed, and for the clarification process on the clarifier inflow, effluent and scums. The settling and clarifier liquors, syrups, liquors off char, sweet water and waste waters were analysed when examining the char filtration process, while liquors, sugar and run-offs were analysed to prepare the ion balance for the crystallization process. The balances are tabulated and discussed. Not all the ionic impurities are removed or transferred to the same degree throughout the refining process; the affination process removes more monovalent ions than bivalent ions, clarification removes bivalent ions and adds monovalent ions (by recirculation of these in remelt sugars), char filtration removes bivalent ions and transfers monovalent ions and the crystallization process transfers both monovalent and bivalent ions to about the same degree. Measurement of these individual ionic constituents is useful to the refinery for control purposes.

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Use of basic lead acetate in cane juice clarification in the laboratory. S. C. SEN, S. S. SIROHI and S. B. S. VERMA. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 43–48.—Formation of lead fructosate changes the optical rotation from laevo- to dextro-, while lead subacetate also has a perciptible effect on sucrose pol. Consequently, formation of lead compounds during clarification may alter pol values and cause discrepancies in pol balances which are then entered as "unknown loss". Addition of the appropriate amount of acetic acid decomposes such compounds, so giving true pol values. Comparative pol balances were drawn up for two factories both with and without using acetic acid; in the first factory the unknown loss was smaller using acetic acid than when not using it; and in the second, use of acetic acid reduced the unknown loss to nil or 0·01%, compared with 0·02–0·06% without acid.

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Measurement of the number and size of crystals in C-massecuite. H. C. BHATTACHARYA amd M. U. OVAISI. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 79–84.—A technique is described for measuring the number and size of crystals in a massecuite; ten spots of massecuite are placed on a tared glass slide which is re-weighed and then examined with a lens system to count the crystals, and examined through a microscope having a calibrated scale in the eyepiece whereby the crystal size can be seen.

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A method for estimation of colloids in technical sugar solutions using surface-active agents. N. A. RAMAIAH and R. D. SRIVASTAVA. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 85–91.—A technique is described in which increasing amounts of 0·02M solutions of cetyl pyridinum bromide or cetyl trimethyl ammonium bromide are added to 5 ml aliquots of cane juice (centrifuged to remove coarse particles and brought to pH 7) and the minimum quantity found which gives a clear supernatant after making up to 10 ml and shaking; this quantity (ml) gives the colloids content in g As_2S_3 equivalent/litre when multiplied by a factor of 17·0.

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Colloids of clarified juices of carbonatation and sulphitation processes. R. D. SRIVASTAVA and K. A. PRABHU. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 93–97.—Colloids in sulphitation and carbonatation process clear juices were coagulated by saturation

with $(NH_4)SO_4$ and maintaining overnight at 4°C. They were separated by centrifuging, re-dispersed in water and dialysed against distilled water and against phosphate buffer of pH 7·4. The solutions were then examined with surface-active agents and electrophoretically. Cetyl pyridinum bromide produced a precipitate with sulphitation juice but not carbonatation, while the reverse applied to sodium lauryl sulphate. It is concluded that the former' juice contains positively charged colloids while the carbonatation juice contains negatively charged particles. This is confirmed by the electrophoretic examination.

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Phosphate content of mixed and clarified juices. S. K. D. AGARWAL. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 99–101. Examination of the phosphate levels of clarified juices of Northern Indian and Deccan factories showed them to be of the same order so that the high lime content of the latter juices cannot be attributed to a difference in phosphate.

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Occurrence of (an) induction period in (the) crystallization of sucrose. N. A. RAMAIAH and S. K. SANYAL. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 145–150.—See *I.S.J.*, 1962, **64**, 333.

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Direct potentiometric pH measurements in sugar solutions and sugar factory juices at elevated temperatures: a contribution to the problem of sucrose degradation in the evaporator station. H. SCHLEGEL. *Zeitsch. Zuckerind.*, 1963, **88**, 14–23.—A special electrode device was used to measure the changes occurring in pH in various solutions on heating to 130°C. The apparatus was housed in an autoclave at a temperature maintained constant by a glycerine bath. The reproducibility of the measurements was determined by comparison of pH measurements of known buffer solutions. The tests were conducted on distilled water, 15% pure sucrose solution, on various buffer solutions, and buffered 0·5–1·5M sucrose solutions as well as factory juices. With distilled water and pure sucrose solutions, the pH fell during 60–100°C and then rose during 100–130°C, the values being 6·9, 4·75 and 8·1 for water, and 6·6, 5·4 and 6·6 for the sucrose. While the temperature coefficients of the pH value differed from one buffer solution to another, the change in pH of the buffered sucrose solutions after 30 minutes' heating from 60 to 130°C differed little from that for the corresponding buffer solutions containing no sucrose. While changes in pH of carbonatation, thin and thick juices were almost the same, the value of Δ pH (the temperature coefficient) varied with time at higher temperatures. For thin and thick juices, the value of Δ pH is approximately —0·013/° as determined from about 80 laboratory tests and several weeks of continuous evaporator measurements. It was found that considerable sucrose decomposition and acid formation occurs after a maximum period of 150 min at 130°C. Attempts to neutralize acid formation with N NaOH while maintaining the pH at its initial value allowed only 1·04% and 8·8% of thick and thin juices, respectively, to be estimated and only provides information on acid formation at the particular pH and at 130°C without indicating autocatalysis of the acid formed. It was found that the acid formation was a function not only of time at high temperatures, but also increased with increasing sucrose concentration. Routine pH measurements in the evaporators during 60 days and paper chromatography of the juices revealed no sucrose decomposition, the total retention time of the juice being 80 min, of which only 28 min was spent at 125–130°C.

* * *

Determination of the specific surface in beet cossettes. F. SCHNEIDER and D. SCHLIEPHAKE. *Gaz. Cukr.*, 1963, **65**, 5.—The concept of specific cossette surface and the measurement of beet tissue permeability by immersing the cossette in a coloured solution of known density or extinction (0·1% neofuchsine at pH 4·6) and determining the decrease in colour of the solution after a definite time are described. To prevent the colour penetrating into the depth of the cossette, 1% tannin was applied to the cossette surface and after an hour it was found that the colour reduction in the solution was much less than in the non-treated cossette. The premeability of cell tissue was determined for ripe, unripe and frozen beet. It was found that the diffusion coefficient in beets frozen several times was 18–20% higher than in the healthy beet, since freezing killed the cells. •

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A new method of determining the diffusion coefficient in beet tissue. S. ZAGRODZKI and J. KUBIAK. *Gaz. Cukr.*, 1963, **65**, 6–8.—See *I.S.J.*, 1963, **65**, 28.

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Tests for the evaluation of the refining qualities of raw beet sugar. P. DEVILLERS. *Sucr. Franç.*, 1963, **104**, 33–35.—This work is the Referee's report on Subject 7 to the 13th Session of ICUMSA in Hamburg in August 1962. Points covered are: (1) the preparation of an affination syrup by dissolving refined sugar to 67·1°Bx, and passing over a mixed bed of 2½ parts of "Amberlite IRA-4015" strong anion exchanger with 1 part of "Amberlite IRC-50" weak cation exchanger. Adoption of a screening technique is recommended for measuring the grist of affined raw sugar crystals and expressing this in terms of MA and CV[3]. It is also recommended that the use of ion exchangers for raw or affined sugar analysis be studied as well as a standard method for carbon or resin decolorization of remelt solution. An appendix describes the preparation of synthetic massecuites from screened white sugar and molasses, together with the tabulated analyses after centrifugalling. These show the important effects of fines and conglomerates on molasses separation during spinning.

[3] POWERS: *I.S.J.*, 1948, **50**, 149.

BY-PRODUCTS

Quality improvement of bagasse hardboard with two smooth sides. C. I. NEE and W. C. HSIEH. *Rpt. Taiwan Sugar Expt. Sta.*, 1962, (29), 77–88.—Removal of samples during manufacture, followed by their processing to the finished product under standard laboratory conditions, permitted the location of stages where conditions were not correct. By correcting these conditions the final product quality was improved, bending strength rising from 360 to 450 kg/sq.cm. Further improvement was prevented by lack of washing equipment to separate non-fibrous matter from the pulp. To improve water-repellency, "Novolak"-type phenolic resins and rosin soaps were precipitated on the fibres at pH 4·6 by solutions of H_2SO_4, $Al_2(SO_4)_3$, 1:1 $H_2SO_4:Al_2(SO_4)_3$, and $Fe_2(SO_4)_3$. Draining speeds were reduced and although the water-repelling quality was improved, the bending strength was reduced. Hardboard without sizing has improved water repellency and bending strength when it is tempered in hot air at 170°C for 2 hr, perhaps as a result of the more uniform enclosure of the fibres by remelted lignin.

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Sucrose derivatives. I. Reaction of sucrose with enol ethers. S. A. BARKER, J. S. BRIMACOMBE, J. A. JARVIS and J. M. WILLIAMS. *J. Chem. Soc.*, 1962, 3158–3161.—Reaction of sucrose in dimethylformamide with vinyl ethers and cyclic enol ethers, with acid catalysis, has resulted in the formation of new sucrose hexa- and hepta-acetals, including one copolymer. Reacting sucrose with divinyl ethers gave oxydiethylidene derivatives.

* * *

Industrial utilization of sugar and sugar by-products. C. R. FLORCRUZ. *Sugar News*, 1962, **38**, 712–714.— A brief survey is presented of Philippine Sugar Institute studies, including pulp and paper from bagasse; yeast, acetic acid and citric acid from molasses; bottled cane juice and molasses/bagasse animal fodder.

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Sucrose-modified phenolic resins as plywood adhesives. C. D. CHANG and O. K. KONONENKO. *Adhesives Age*, 1962, **5**, (7), 36–40; through *J. Appl. Chem. Abs.*, 1963, **13**, i–248.—The present method of preparation is described and 33% sucrose by weight is incorporated which replaces approximately one half of the phenol used in the preparation of the normal phenolic resin. The high water resistance and the definite maximum in the mechanical properties, as a function of sugar content, shows that the sucrose is entirely bound and the optimum ratio is sucrose 1·0, phenol 3·5 and formadehyde 9 moles.

* * *

Pulp storage and enrichment with nitrogenous substances. L. E. FLEISHMAN. *Sakhar. Prom.*, 1963, (2), 14–19.—Beet pulp for use as animal fodder is stored at Soviet sugar factories in open pits and consequently deteriorates, losing much of its nutrient qualities.

Storage in silos is therefore advocated, and recommendations are given on its dewatering before storage. In feeding trials, ammoniated silo-storage pulp gave the highest cattle weight increase—19·5% compared with the control (open-stored pulp), followed by silo-stored pulp with HCl added and ammoniated before feeding, and ammoniated open-stored pulp. Silo-stored pulp with HCl added gave a reduced meat yield.

* * *

Studies on the fixation of ammonia by beet pulp. K. PUJSZO. *Roczniki Nauk Rolniczych*, 1961, Ser. B, **78**, 237–242; through *S.I.A.*, 1962, **24**, Abs. 1018. Ammoniated and non-ammoniated pulps were extracted with solutions of various salts, acids or alkalis and their nitrogen contents were analysed. Alkali-treated pulp lost the capacity of fix NH_3, but the full capacity was restored by treating the pulp with acid. Finer particles absorbed relatively less NH_3 than did the coarser particles. It is concluded that the fixation is of a chemical nature and is mainly centred on the pectin fraction (containing $\sim 85.6\%$ of total fixed N).

* * *

New grist to the mill. Bagasse. ANON. *British Printer*, 1962, **75**, (11), 97–99.—Bagasse fractionation by the Cusi method into its various components and subsequent pulping are discussed. Tests carried out by the *Macclesfield County Express* in collaboration with Simon Handling Engineers Ltd. (manufacturers of bagasse pulping machinery) demonstrated that newsprint made from 90% bagasse pulp at the pilot plant of Cia. Industrial de San Cristóbal (Mexico) had good mechanical strength and high ink absorption, but had poor printing quality.

* * *

Glutamic acid in final molasses from Ukrainian beet sugar factories. II. I. M. LITVAK and E. A. GRIVT-SEVA. *Trudy Kiev. Tekhnol. Inst. Pishch. Prom.*, 1962, **25**, 6–9.—Molasses samples from 60 different factories representing all the *oblasts* of the Ukraine were studied and the glutamic acid contents for the 1960/61 campaign compared with the 1959/60 figures. The figures are presented as averages for each *oblast*. As was found previously[1], the highest content occurred where the average air temperatures were highest and the rainfall during growth of the beet lowest. It was found that these two factors have greater influence on the glutamic acid content of the beet than the quantity of nitrogenous fertilizer applied. However, the chemical composition of the soil should also influence the glutamic acid content, but this factor was not considered in the studies.

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[1] *I.S.J.*, 1962, **64**, 345.

TRADE NOTICES

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

Rotating pressure filter. Suchar Sales Corporation, 9 East 41st Street, New York 17, N.Y., U.S.A.

An advanced pressure filter has been added to the line of filtration and clarification equipment made by Suchar Sales Corporation. Exhaustively tested in trial and plant runs, the first filter is already in operation in a Louisiana sugar refinery. Called the "Auto Filter 22", this rotating, vertical leaf filter is an improved version of the original "Auto Filter", which has been successfully used by process industries since 1926.

A sluicing-type filter with stainless steel leaves, the "Auto Filter 22" has been specifically designed for simple, economical operation. One man can operate several units. Filtering, washing, cake discharge and cleaning are all easily controlled by valves without opening the shell. A unique filtrate system assures that the filter always remains full during operation. Rotation contributes to uniformity of operation. Alternative filtrate discharge arrangements are available: all leaves may discharge to a common manifold, or, when greater control is desired, the leaves may discharge separately through an individual sight glass and shut-off cock. The filter requires little maintenance. Filter covers are easy to apply and the low height of the filter makes occasional redressing a simple operation.

Complete technical information on this new and improved filter is contained in an attractive four page folder, which includes a full-colour, cut-away drawing, showing the operating features in careful detail. This folder is available on application to the Corporation.

* * *

The Russell drum and sack tipper. Russell Constructions Ltd., Russell House, Adam Street, London, W.C.2.

This drum and sack tipper has been designed to eliminate manual handling completely when tipping the contents of drums or sacks into any type of orifice, chute or container.

It consists of a strongly constructed frame which holds a neatly arranged power pack in which a 1 h.p. motor operates a single hydraulic ram. It is worked by means of a hand lever which provides finger-tip control over the most difficult tipping operation. If necessary the cradle which supports the container can be "inched" in order to provide an accurate control over the discharge of the contents.

The tipping cycle is fifteen seconds and a universal attachment is available if it is required to handle both drums and sacks.

The machine is compact, having an overall length of 4 ft 3 in and an overall height of 3 ft 3 in, with an unladen weight of 3 cwt. It is mounted on heavy duty castors which make it easily manoeuvrable both in a laden or an unladen condition. Handrails are provided as a protection for the operator.

* * *

Silos in reinforced plastics. Halmatic Ltd., Wymeswold Aerodrome, Nr. Loughborough, Leics.

A method of constructing small silos in structural reinforced plastics has been developed which has many advantages over conventional metal silos and increases the attractions of bulk handling. Two silos holding 32 tons of flour are shown operating successfully at a bakery.
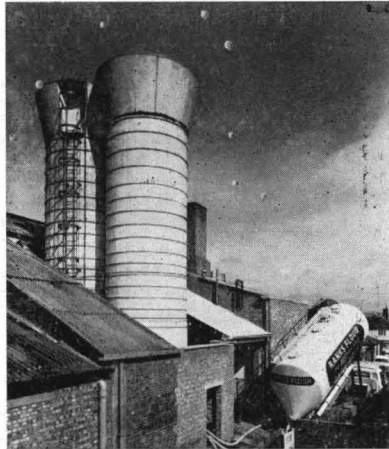
The silos are of double shell construction and incorporate a rigid plastic foam for insulation; being weatherproof they need no enclosing building. This saves costs and reduces delivery time. Maintenance costs compared with a conventional installation are dramatically reduced owing to the self-coloured, non-corroding material.

The shells have no joints or internal obstructions and the contents cannot stick to the polished surface.

The silos are 45 ft high overall with an internal diameter of 10 ft. The contents discharge through a cone contained within a structural skirt. There is an upper chamber housing apparatus and giving access through a working platform to the silo interior. The internal pressure from the contents is resisted by direct hoop tension in oriented strength members.

The weight is largely carried by the cone, the load then being transferred into the structural support skirt. The low weight achieved in these silos improves portability and greatly facilitates installation. There is very little site work to be done since even with the 32-ton silos most of the structure is integrated at the factory.

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PUBLICATIONS RECEIVED

BEET WASHER. CEKOP, P.O. Box 112, Warsaw, Poland.

The main body of the washer consists of a trough with three perforated bottom sections and corresponding earth and sand catchers, a main shaft, with hooks for moving the beets, and a straw and leaves catcher. Beets are removed from the washer by an inclined scroll which lifts them to the beet elevator, a perforated section being at the end of the scroll trough to permit drainage. An automatic device is provided, activated by the main shaft of the washer, which opens the valves of the mud catchers at intervals so that it is washed out by a stream of outflowing water.

* * *

ESCHER WYSS. Escher Wyss Ltd., Zürich, Switzerland.

A new leaflet illustrates the Zürich plant of Escher Wyss Ltd. and those of its German and Italian subsidiaries at Ravensburg and Schio. It gives details of the manufacturing programme which includes water turbines, turbo-pumps, pipelines, butterfly valves and gates, marine propellers, refrigerating machines, heat pumps, evaporators, centrifugals, steam boilers, cement making machines, drum dryers, paper machinery, steam and gas turbines, turbo-compressors and turbo-blowers.

Brevities

Fletcher milling plant for South America.—George Fletcher & Co. Ltd., of Derby, have recently received orders from South America totalling more than £180,000. For Haciendas San Jacinto and Tumán in Peru they are to supply equipment including gearing for mill drives, bedplates, reduction gears and steam turbines. At both of these factories this is the first stage of modification to milling plant involving conversion from steam engine to turbine drive. In 1962 Fletcher supplied two 26×48 in mills, complete with turbine drive and gearing to San Carlos sugar factory in Colombia. These have already been in operation on one crop and now the final phase in modernizing the milling plant is being carried out. Four new mills with Edwards hydraulics and Farval mechanical lubrication have been ordered. The intermediate carriers will be of the rubber belt type and two single-stage forced lubrication steam turbines will provide the drive through double reduction spur and helical gearing, completing the 18-roller milling tandem.

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£150,000 Rhodesian order for irrigation plant.—Wright Rain Ltd., of Ringwood, Hants., has won an order, expected to be worth more than £150,000, to supply equipment for Triangle Sugar Estates Ltd.'s new 5000-acre estate in Southern Rhodesia. Delivery began in July and the installation will be completed in time for the estate to be planted to cane before the end of the year. The extension to Triangle Estates is being created from scrubland which, until reclamation began earlier this year, supported only wild life. The average rainfall is only 14 inches and the temperature reaches 120°F at the hottest time of the year so that crop production would be impossible without irrigation. With it, the estate will produce about 40,000 tons of sugar per year. The estate lies about 100 miles southeast of Fort Victoria and will draw water from the Kyle Dam. Water from the dam will flow through 60 miles of river and 40

miles of canal on its way to the estate where it will be applied at the rate of 2 inches per acre every week for nine months of the year. The Wright Rain equipment will be at work six days a week and 24 hours a day. As an inch of water represents 22,000 gallons per acre, the total amount of irrigation to be applied in a season will be approximately 5000 million gallons—enough to meet the average needs of a town of 300,000 people.

* * *

English Electric steam turbine for the Philippines.—A $150,000 order for a 400V 2000 kW English Electric backpressure steam turbine for the Canlubang sugar estate at Luzon, Philippines, was recently completed. The set illustrated provides up to 72,000 lb of steam per hour for processing and also the
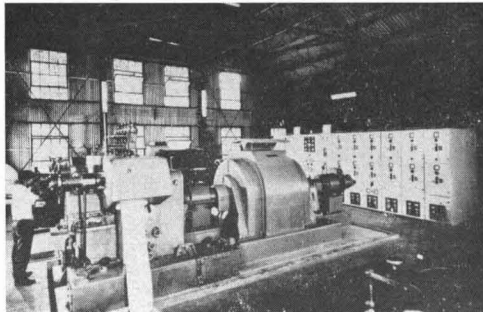
electrical power for running the factory. The contract also included an 11 panel class "M" switchboard containing the alternator/exciter control gear, control gear for an existing 1000 kW set and nine 800 amp and three 1600 amp feeders.

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Char kilns for Tate & Lyle.—Huntington, Heberlein & Co. Ltd., a member company of the Simon Engineering group, has been awarded a contract by Tate & Lyle Refineries Ltd. for two Herreshoff bone char kilns to be built at Plaistow Wharf refinery.

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Western States centrifugals for Puerto Rico.—The battery of seven Western States centrifugals illustrated is now in operation at Central Aguirre Sugar Co. in Puerto Rico. This is the third time that the station has been modernized since 1935 and each time Western States machines have been selected. All
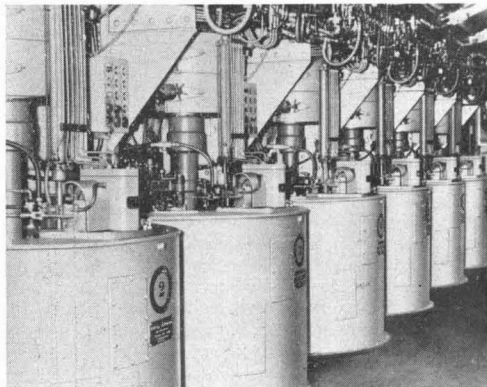
seven centrifugals are of the latest design and are completely automatic from loading to ploughing; cycles are repeated automatically and each machine starts at a fixed time after its predecessor.

BREVITIES

New sugar factory for Mozambique[1].—Segura-Bartoli of Valladolid, Spain, have been appointed general contractors and suppliers for a new cane sugar factory for Mozambique which is to have a capacity of 3600 metric tons of cane per day, sugar extraction to be carried out using a De Smet continuous diffuser.

* * *

New U.S. beet sugar factory[2].—American Crystal Sugar Co., of Denver, Colorado, plans to erect an $18-million beet sugar factory near Drayton, North Dakota, with a capacity of 6000 tons of beet per day, to be completed in the autumn of 1965.

* * *

Lobo research fellowship.—JULIO LOBO, sugar industrialist and former student at Louisiana State University, where he graduated in 1919, has established a $12,000 graduate fellowship at LSU which is to support basic research in sugar technology with particular application to the development of new non-edible products derived from sugar.

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Chilean sugar industry expansion[3].—The Government of Chile is studying the possibility of installing two further beet sugar factories with a combined annual capacity of 25,000 tons.

* * *

New beet sugar refinery for Spain[4].—The sugar beet cooperative, Onésimo Redondo, of Valladolid, is planning the erection of a new sugar refinery with an annual refining capacity of 200,000 tons of beet sugar. The programme calls for an investment of 400 million pesetas (£2·4 million) and tenders for the construction of the plant and supply of machinery will be issued later in the year.

* * *

Peru sugar production, 1962[5].—Sugar production in Peru in 1962 amounted to 762,607 tons as compared with 797,945 tons in 1961. Exports have been put provisionally at 462,385 tons or some 15·2% under exports in the previous year.

* * *

Lebanon planning self sufficiency[6].—The Lebanon Government has a three year plan to increase the growing of sugar beet and sugar cane so that enough sugar can be produced locally to meet the country's needs. The Ministry of National Economy is to study tariff arrangements on the basis of cost of production plus a profit of 8% and the taxes collected on sugar. The retail selling price will also be established by the Ministry. Although the plan is not scheduled to start until January 1st next year, it is understood that the Ministry has decided in principle that the sugar refineries in the Lebanon should buy the beet and cane crops from growers at prices fixed by the Ministry in order to encourage right away the planting of these crops.

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Bagasse paper plant for Brazil[7].—Negotiations have been in progress with the East German authorities regarding help in setting up a plant in North-East Brazil to manufacture paper from bagasse.

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Puerto Rico sugar crop, 1961/62[8].—According to the U.S. Dept. of Agriculture, 1962 production of sugar in Puerto Rico totalled 1,006,907 short tons, raw value, this figure including 2388 tons of 1962/63 crop sugar produced in December 1962 but excluding 2882 tons of 1961/62 crop sugar produced in December 1961. Local consumption amounted to 109,709 tons while 134,924 tons was refined in Puerto Rico for the U.S. Mainland market and 760,810 tons shipped direct to the Mainland.

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Sugar beet autumn demonstration.—A demonstration of sugar beet cleaner-loaders is planned for an aerodrome site at Great Ashfield, near Bury St. Edmunds, Suffolk, on the 20th and 21st November. It is expected that at least 15 cleaner loaders and 12 sugar beet harvesters will be operated.

French Imports and Exports

Metric tons

Imports	1962 Unrefined	Refined	1961 Unrefined	Refined
Belgium/Luxembourg	88	1,629	114	2,907
Brazil	—	—	7,578	—
Cuba	—	4	—	23
Dominican Republic	99	18	100	15
Germany (West)	25	—	—	—
Guadeloupe	112,895	—	97,801	—
Holland	66	310	67	455
Malagassy Republic	29,678	—	17,198	—
Martinique	73,992	—	58,557	—
Poland	20,522	7,318	—	—
Réunion	181,923	—	206,717	—
Other Countries	1	7	—	31
	419,289	9,286	388,132	3,431
Exports				
Algeria	116,880	54,557	142,746	57,146
Argentina	—	51	—	5,932
Belgium/Luxembourg	699	11,738	974	2,289
British East Africa	—	—	—	774
British West Africa	—	—	—	3,480
Cameroons	984	4,521	826	3,419
Cyprus	—	—	671	—
Dahomey	280	6,511	458	5,221
Ethiopia	—	500	—	350
Gabon Republic	104	698	103	595
Germany (West)	29,444	8,971	21,558	5,973
Ghana	—	13,410	—	11,963
High Volta Republic	362	5,019	2	6,243
Holland	37,967	30,073	30,688	63,470
Iran	—	—	19,411	9,816
Ireland	32,477	—	—	—
Italy	12,599	10,792	9,337	10,828
Ivory Coast	4,410	9,894	5,105	14,242
Japan	—	—	19,959	—
Liberia	—	969	—	1,052
Malaya	—	—	—	1,100
Mali	—	2,042	—	—
Mauritania	—	8,999	15	5,456
Morocco	3,683	38,301	45,868	50,476
Niger Republic	733	4,601	130	3,899
Nigeria	—	12,290	55	12,248
Norway	—	437	—	7
Oasia and Saoura	6,145	5,430	—	—
Pakistan	—	2	—	1,016
Sahara	—	—	2,146	6,074
Senegal	20,400	28,218	20,670	27,494
Sierra Leone	—	4,386	—	—
Spain	—	—	50	1,668
Spanish Territories in Africa	—	1,251	—	28
Sudan Republic	—	—	175	5,219
Switzerland	18,949	91,851	26,627	86,327
Togo	232	3,932	126	2,388
Tunisia	—	—	4,251	5,862
United Kingdom	5,328	3,093	34,939	23,901
Uruguay	2,000	—	—	—
U.S.A.	—	—	1,500	12,201
Vietnam	333	—	9,497	—
Other Countries	743	1,350	899	946
	294,752	363,887	398,786	449,103

[1] *Sugar y Azúcar*, 1963, **58**, (5), 11.
[2] *Sugar y Azúcar*, 1963, **58**, (5), 46.
[3] *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 490.
[4] *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 495.
[5] *Zeitsch. Zuckerind.*, 1963, **88**, 283.
[6] *Public Ledger*, 8th June 1963.
[7] *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 355.
[8] *Willett & Gray*, 1963, **87**, 252.
[9] *G.N.I.B.C.*, through C. Czarnikow Ltd., *Sugar Review*, 1963, (602), 59.

B.W.I. Sugar Production and Consumption[1]

	Production		Estimate
	1961	1962	1963
Antigua	21,035	20,536	28,500
Barbados†	159,541	158,458	185,000
British Guiana ..	324,745	326,023	330,000
Jamaica	439,632	433,990	468,700
St. Kitts	46,657	42,863	43,000
St. Lucia	5,566	3,894	2,516
Trinidad	245,681	201,091	226,800
	1,242,857	1,186,855	1,284,516

	Local & Neighbouring consumption			Estimated available for Export
	1961	1962	Estimate 1963	1963
Antigua	1,717	1,566	1,600	26,900
Barbados†	11,676	11,032	10,500	177,648*
British Guiana ..	21,696	23,064	22,000	310,954*
Jamaica	63,014	64,613	66,000	398,937*
St. Kitts	4,043	4,122	4,200	38,800
St. Lucia	1,919	1,888	2,016	500
Trinidad	30,934	32,350	37,000	189,800
	134,999	138,635	143,316	1,148,139

† *Production and export figures include fancy molasses.*
* *Includes stock at end of 1962.*

Breviities

Bolivian sugar prospects[2].—It is anticipated that 1963 will be the first year in which Bolivia will manufacture sufficient sugar to take care of domestic needs. Present indications are that the four mills will produce about 60,000 metric tons this season as compared with 49,191 tons in 1962, according to Reuter. It was in 1961 that Bolivia originally announced measures to step up production so as to obviate the need to supplement domestic output and possibly to have a small quantity available for export. A new mill is scheduled to commence operations next year and this, together with improvements to the existing factories, should bring about a considerable increase in production.

* * *

Greek beet area[3].—The beet area for the 1963/64 season in Greece amounts to 23,750 acres, an increase of 7689 acres over last season's, from which 120,000 tons of roots were obtained. Given favourable weather conditions before the opening of the campaign, it is anticipated that the beet crop could exceed 300,000 tons which is considered to be enough to satisfy the needs for the country's two sugar factories. A third factory, situated at Serra, will open for a trial run during the 1963/64 season.

* * *

Possible sugar futures market in Paris[4].—The Paris Chamber of Commerce has given the green light for the setting-up of a sugar futures market in Paris. A spokesman for the Chamber said that a general assembly meeting "expressed the wish to see an international market in white sugar set up in Paris." The spokesman declined to elaborate but said that the draft proposals would be submitted shortly for Government approval.

* * *

New Burmese sugar factories[5].—With finance being found from the £30 million loan from China, work is expected to commence in the near future on the construction of two 1000 tons cane/day sugar factories. The factories will be at Bilin, 130 km east of Rangoon, and at Paungde in Karen State[6]. At present there are four factories fully operational in Burma and originally it had been the Government's intention that a further four be built; however, it now appears that the country's domestic needs can be satisfactorily met out of the production from six factories.

Stock Exchange Quotations

CLOSING MIDDLE

London Stocks (*at 17th July 1963*)

Anglo-Ceylon (5s)	18/-
Antigua Sugar Factory (£1)	8/6
Booker Bros. (10s)	20/-
British Sugar Corp. Ltd. (£1)	36/-
Caroni Ord. (2s)	4/-
Caroni 6% Cum. Pref. (£1)	14/9
Demerara Co. (Holdings) Ltd.	7/9
Distillers Co. Ltd. (10s units)	33/1½
Gledhow Chaka's Kraal (R1)	19/6
Hulett & Sons (R1)	52/-
Jamaica Sugar Estates Ltd. (5s units) ..	4/7½
Leach's Argentine (10s units)	22/-
Manbré & Garton Ltd. (10s)	50/9
Reynolds Bros. (R1)	20/9
St. Kitts (London) Ltd. (£1)	15/-
Sena Sugar Estates Ltd. (10s)	8/3
Tate & Lyle Ltd. (£1)	50/3
Trinidad Sugar (5s stock units)	4/6
United Molasses (10s stock units)	38/3
West Indies Sugar Co. Ltd. (£1)	17/6

CLOSING MIDDLE

New York Stocks (*at 16th July 1963*)

	$
American Crystal ($10)	65½
Amer. Sugar Ref. Co. ($12.50)	28⅜
Central Aguirre ($5)	28
North American Ind. ($10)	18⅛
Great Western Sugar Co.	45½
South P.R. Sugar Co.	41⅜
United Fruit Co.	26½

Brevities

The late Dott. Leo Cavallaro.—We regret to announce the death in Ferrara of Prof. Dott. Leo Cavallaro, who was aged 58. Prof. Cavallaro was Dean of the Faculty of Science and Director of the Chemical Institute in the University of Ferrara as well as Director of the "Serafino Cevasco" sugar school. He was President of the Italian Association of Sugar Technologists and a member of the Scientific Council of the C.I.T.S. as well as President of the Italian National Committee of ICUMSA. He had been awarded the Gold Medal for Science and Culture, and was widely known for his work on moisture, amino-acids and other non-sugars in sugar.

* * *

Large boiler for Puerto Rico[7].—One of the world's largest bagasse-fired boilers has been placed in operation by South Puerto Rico Sugar Corporation at their Guánica sugar factory. The boiler, supplied by The Babcock & Wilcox Company, has a generating capacity of 220,000 lb of steam per hour at peak load.

* * *

Bagasse board plant proposed for Puerto Rico[8].—C. Brewer (Puerto Rico) Inc., Commonwealth Oil Refining Co. Inc. and National Bagasse Products Corporation have entered into an agreement which envisages the construction by the last-named Company of a bagasse board plant in Puerto Rico.

[1] *Willett & Gray*, 1963, **87**, 285.
[2] C. Czarnikow Ltd., *Sugar Review*, 1963, (614), 108.
[3] C. Czarnikow Ltd., *Sugar Review*, 1963, (614), 109.
[4] *The Times*, 8th July 1963.
[5] C. Czarnikow Ltd., *Sugar Review*, 1963, (614), 109.
[6] *Zeitsch. Zuckerind.*, 1963, **88**, 339.
[7] *Sugar J.* (La.), 1963, **26**, (1), 74.
[8] *Sugar J.* (La.), 1963, **26**, (1), 76.