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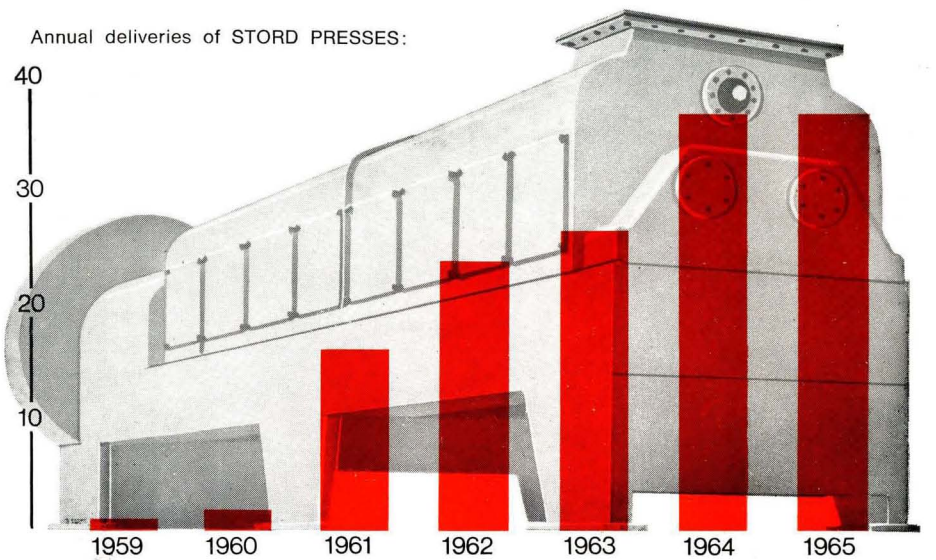

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THE
INTERNATIONAL SUGAR JOURNAL

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NOTES AND COMMENTS

Sugar in the West Indies.

SIR ROBERT KIRKWOOD, Chairman of the British West Indies Sugar Association (Inc.), presented a survey of the work of the Association during the 1963/64 period at the 24th Ordinary General Meeting in Barbados in December.

He recorded that for the second year running a delegate has resigned following the ending of sugar production in the territory he represented. The Association has given the same assurance to St. Lucia as to St. Vincent that their rejoining would be welcome if changed circumstances permitted a resumption of cane sugar manufacture in the island.

Detailed accounts were given of crop levels and field and factory developments in 1962/63 and 1963/64, for the individual islands and British Guiana. A hopeful sign was the reduction in unexplained cane fires in Antigua, although they increased in Barbados, resulting in below-average sugar production. The disastrous effects in British Guiana of a combination of drought and man-made problems—labour unrest, arson, work stoppages, etc.—were described, the sugar outturn having fallen from a normal 125,000 tons to only 78,000.

Hurricane damage to the crop, plus the effects of a drought in Jamaica, reduced sugar production in Grenada and Jamaica, while low deliveries of cane by farmers resulted in a fall in the Trinidad sugar outturn. As a result of these difficulties the record 1963 tonnage for the Association's members of 1,288,574 tons was expected to fall to 1,218,333 tons in 1964, against the original forecast of 1,303,400 tons. All the exportable sugar should be required to meet outlets in the U.K., Canada and the U.S.A.

SIR ROBERT stressed the need to maintain export performance at the highest possible level in present circumstances, not only to ensure consideration for a claim for the maximum possible quota for supply to the U.S.A. but also in the international sphere since, if a new quota-type International Sugar Agreement is negotiated in the near future, individual countries' export performances will be a vital factor in the bargaining for basic quotas.

Mauritius sugar crop, 1964[1].

The 1964 crop started on the 29th June and ended on the 1st December 1964. The 23 mills together crushed 4,311,463 tons of cane, and 511,389 tons of sugar was produced as compared with 674,800 tons in 1963. The average sugar recovery was 11·86% and cane yield averaged 21·2 tons per acre. As a result, the yield of sugar per acre (on a harvested area of 203,254 acres) amounted to 2·52 tons as against 3·33 tons in 1963.

The 1964 sugar output is the lowest since 1954, with the exception of the year 1960. The reduction in sugar production is due to the damage caused by the cyclones Danielle and Giselle which passed in the vicinity of Mauritius in January and February, respectively. Earlier, a prolonged drought had also caused some harm to plantations.

Sugar exports during 1964 amounted to 560,450 tons, of which the bulk (410,580 tons) were shipped to the U.K. Of the remainder, 134,881 tons went to Canada, 9989 tons to Italy and 5000 tons to Malaysia. This compares with exports of 571,227 tons in 1963.

* * *

U.K. sugar imports and exports, 1964.

Elsewhere in this issue appear details of the 1964 sugar exports and imports for the United Kingdom. Exports total some 437,000 tons, an increase of 35,000 tons on the 1963 figures and the highest since 1960. A third of this increase was among Commonwealth countries, the most substantial increase being in the Red Sea area with 15,500 tons more for Aden, Bahrein, Kuwait, etc. The 6000-ton drop for Tanganyika is partly offset by the 2800-ton increase for Ghana, although the 1963 and 1964 figures for the latter are much lower than the 21,000 tons taken in 1962. Kenya's imports from the U.K. were also 3000 tons lower, while increases of nearly 3000 tons were recorded for Cyprus and Nigeria.

There were some marked changes in exports to non-Commonwealth destinations. The important in-transit refining for West Germany disappeared as did exports to the Sudan and much of the former

[1] *Mauritius Sugar News Bull.*, 1964, (12).

business with Norway and Switzerland. There were several considerable increases elsewhere, however, the largest being over 100,000 tons more for the Netherlands, and others in Greece (26,000 tons), Iran (9400 tons), Saudi Arabia (24,000 tons) and Sweden (10,000 tons).

The bulk of the imports of the U.K. again came from the Commonwealth, although the proportion was slightly lower than in 1963. Total raw sugar intake was down by 150,000 tons and refined sugar by 85,000 tons to only 56,000 tons or less than 2½% of the total imports.

The B.W.I. and British Guiana supplied less sugar in 1964 as did India, Mauritius, South Africa, Cuba, Czechoslovakia, East Germany and the U.S.S.R. Increases were made in the imports from Australia, Rhodesia, Argentina, Belgium, Brazil, Denmark, Dominican Republic, Indonesia, Mexico and Peru.

* * *

Increase in U.K. sugar surcharge.

The Sugar Board surcharge of 4d per lb (37s 4d per cwt) was increased to 4¼d per lb (39s 8d per cwt) from the 26th January and then again to 4½d per lb (42s 0d per cwt) from the 9th February. Since the previous change in surcharge on the 11th December 1964, the ex-refinery price of sugar had fallen from 79s 6d per cwt to 72s 10½d over the period, and the increases in surcharge offset by about 4s 8d this fall of 6s 7½d.

* * *

Brazil sugar situation[1].

Brazil is at present suffering from the difficulty of having brought forward into the new year an unduly heavy stock whilst at the same time a record crop is in prospect. According to statistics which have been published recently, stocks in hand at the 31st December amounted to 1,449,000 tons compared with 964,000 tons at the end of 1963 and the previous largest ever end-year carry-over of 1,259,000 tons in 1959. Meanwhile domestic consumption, which had risen rapidly to more than 2,800,000 tons in 1962, fell during the following two years and amounted to 2,672,000 tons in 1964. Exports have fallen almost constantly from the 855,000 tons shipped in 1960 to less than 268,000 tons in 1964.

Production in Brazil passed the three million tons mark in 1958 but thereafter the expansion rate slowed down and by last year it had reached only 3,425,000 tons. Reports have circulated recently that output during the campaign year June 1965 to May 1966 may leap forward to four million tons or more and although it has been estimated that consumption is likely to rise to about 3,100,000 tons, the need for Brazil to take effective measures to increase her exports is obvious.

Since 1960 the U.S.A. has been an important market for Brazilian sugar. This is, however, limited by quota and the quantity of Brazilian sugar which can be imported into that country during 1965 under present arrangements is some 180,000 metric tons and, although it is anticipated that at a later stage the freeing of the U.S. reserve quota will permit the entry of a further 20,000 tons of Brazils, this would seem to be the limit of Brazil's hopes in that direction unless deficits are declared by other suppliers or the U.S. Secretary of Agriculture increases the Supply Quota.

* * *

U.S. supply quotas 1965.

Import tonnages granted by the U.S. Dept. of Agriculture for delivery during the second quarter of 1965 were announced on the 19th January and are tabulated below, together with the accumulated tonnages granted for the first six months. As reported earlier[2], deliveries in the first three months were limited to 500,000 short tons, raw value, and in the second three months to a further 1,200,000 tons.

	Tonnage April–June	*Tonnage January–June*
Argentina	25,728	30,173
Belgium	1,509	1,509
Brazil	72,042	105,845
British Honduras	1,742	1,742
British West Indies	54,946	69,685
Colombia	11,738	11,738
Costa Rica	22,454	22,454
Dominican Republic	205,839	259,882
Ecuador	5,680	11,392
France	5,164	5,164
French West Indies	30,426	30,426
Guatemala	17,890	29,885
Haiti	11,927	17,925
India	44,718	56,524
Mexico	222,540	310,820
Nicaragua	15,213	23,276
Panama	3,548	9,368
Peru	83,846	109,160
Philippines	297,781	487,262
El Salvador	12,710	12,710
South Africa	—	31,169
Taiwan	51,202	60,534
Turkey	1,357	1,357
	1,200,000	1,700,000

* * *

Cuban sugar information policy[3].

Cuban sugar crop figures for this year might be published at the end of the harvest, Premier FIDEL CASTRO said in a speech in Havana on the occasion of the sixth anniversary of the revolution. Observers feel that this could mean an end to the official policy under which a total blackout has been imposed on sugar statistics.

The Cuban Premier said in the course of his speech that Cuba needs to harvest 5,500,000 tons of sugar to fill his country's obligations. Diplomatic sources believe the cane now standing in the fields represents a potential harvest of 5,500,000 tons but they say that, as in the past, labour shortages and transport problems continue to be the main obstacles to a full outturn.

[1] C. Czarnikow Ltd., *Sugar Review*, 1965, (698), 29–30.
[2] *I.S.J.*, 1965, **67**, 33.
[3] *Public Ledger*, 9th January 1955.

SUGAR CANE CULTIVATION IN SOUTH AFRICA

Proceedings of the 37th Annual Congress, South African Sugar Technologists' Association, 1963

Mosaic Disease

AS in many other sugar cane growing countries, mosaic disease continues to be troublesome in Natal. Disease survey work during 1961–62 revealed a disconcerting number of cases of mosaic in the variety N:Co 376. The degree of infection with this variety was increasing and it was apparent that the disease was having a very adverse effect on it. The survey also showed that the reaction of the variety N:Co 339, traditionally regarded as tolerant, was open to question.

These facts and some other considerations led to an experiment being laid down at the Experiment Station at Mount Edgecombe to determine more precisely the effects of mosaic disease on five well known varieties, an account of which is given by G. M. THOMSON. Plots were represented by single stools. The two treatments were "planted healthy" and "planted diseased". Results from the plant cane crop and first ratoon crop showed that N:Co 339 was more tolerant than the other varieties but it could not be said to be unaffected by mosaic disease. Tolerance of N:Co 334 was of the same order. The variety N:Co 376 showed the least tolerance, while N:Co 292 and N:Co 293 were affected to about the same extent. There was some evidence of recovery from mosaic in N:Co 292 and to a lesser extent in N:Co 293 and N:Co 339.

Green Leaf Sucker

An account of the green leaf sucker of sugar cane in Natal (*Numicia viridis*), a comparatively "new" insect pest, is given by J. DICK. The initial outbreak in Swaziland on the variety N:Co 310 is discussed. A description of the insect is given and its effect on cane. Among control measures, burning and harvesting of millable cane and treatment of the remainder with "Malathion" dust were effective in reducing infestation. [Since this paper was written large scale aerial spraying with "Malathion" has taken place.]

Herbicides

Useful results from extensive tests on different weedkillers in Natal are given by G. D. THOMPSON and J. M. GOSNELL in their paper "The results of herbicide trials conducted in the cane belt of Natal 1962/63". The writers point out that so far modern herbicides have not found wide acceptance in Natal. For this they give two reasons—the relative cheapness of hand labour (compared with other countries) and the uncertain or eneven rainfall in the cane belt, herbicidal activity having been shown to be extremely dependent upon soil moisture conditions. Under irrigated conditions this severe limitation falls away almost entirely.

"Paraquat" proved to be the most consistently efficient herbicide under Natal conditions, but its high cost is a drawback. It gave good post-emergent control of the two most important weeds, water-grass (*Cyperus esculentus*) and Guinea grass (*Panicum maximum*), as well as the majority of other weed species. The symptoms of severe cane leaf scorching observed after "Paraquat" applications soon disappeared, and ratings for cane vigour after three months showed "Paraquat"-treated cane to be among the best. "Paraquat" is at present too expensive for field recommendations. "Diquat" gave fairly good control of most weeds except grasses. "Dalapon" was useful where grasses were the main problem. DCMU gave good results where soil conditions were uniformly moist and it also seemed to improve cane vigour. Of the remaining herbicides, CMU, "Stam 34" and "Kuron" showed some promise, while "Eptan" gave such good control of *Cyperus esculentus* that further work with this chemical is planned to reduce or eliminate its depressing effect on sugar cane.

Water Requirements

A paper on the estimation of the water requirements of sugar cane in Natal by G. D. THOMPSON, C. H. O. PEARSON and T. G. CLEASBY gives the results of replicated lysimeter trials. The authors point out that some knowledge of the water requirements of a crop is essential if an irrigation scheme is to be planned and operated successfully. At the present time more and more cane is being put under irrigation in South Africa. The lysimeter trials were on two sites and provided the means during the last three and a half years of measuring the potential evapotranspiration of sugar cane. The results indicate that the water requirements vary from a maximum of 0·24 inches per day in January to a minimum of 0·09 inches per day in June. It is shown that moisture deficits may occur at any time of the year and that the short periods of summer drought are most severe in depressing crop yield.

Fertilizer Trials

In "Competition in fertilizer trials" H. M. DICKS discusses the influence of "border effects" on experimental results, while the findings of research workers in Hawaii, Louisiana and Queensland are summarized. The results of a "long term" fertilizer trial which was harvested in sections to test the influence of "end" and "side" effects on treatment means and responses are presented and discussed. Side effect, measured by the successive elimination of outer rows, appears to have a marked influence on the "response" to nitrogen, the reduction in mean yield being greatest for the "no-nitrogen plots". End effects would appear to vary with treatment and interactions. The reduction in mean yield associated with the elimination of end effects is quite considerable—10%—but becomes relatively smaller with the increased fertility of the plot.

The "Hydrograb" Cane Loader

A description is given of this loader, first produced in Durban, and of the improvements that have been made during three trial seasons with it. The writer (G. S. BARTLETT) summarizes as follows—"The 'Hydrograb' loader fitted to a Massey-Ferguson 205 tractor and 702 loader is able to load cane satisfactorily on to either golovans (narrow gauge rail trucks) or trailers, without excessive or unreasonable mechanical failures. This unit will fit into the average harvesting system presently found on gently sloping terrain on the Natal cane farm, without upsetting the normal routine. The machine is able to load at an average loading rate of 11·5 tons per hour and this can be increased to as much as 15 tons per hour under suitable conditions. Its use will result in an average increase of 82% in the cutter's output and therefore will considerably reduce the required number of cane cutters."

F.N.H.

TRIAL SUGAR CANE CULTIVATION IN WESTERN AUSTRALIA

UNDER the title of "Ord River Sugar Industry Proposals" an account is given[1] of preliminary trials with sugar cane under irrigation in the Ord River area, which is situated in the northern part of Western Australia, within the tropics[2]. If the proposal to establish a sugar industry, along with cotton or other crops, under irrigation from the Ord River, develops, the port of Wyndham would be well situated to serve it.

Occupation of the Ord Valley began in the latter part of last century and a small agricultural experiment station was established in 1941. "Systematic examination of the irrigation potential began with a soil survey of 86,000 acres by the Western Australian Department of Agriculture in 1944. This disclosed that 56,000 acres were potentially irrigable and that a further 125,000 acres of generally similar land required examination. In 1945 the Kimberley Research Station was established some miles downstream from the original research plot, as a joint venture between the Federal and State Governments. The immediate aim was to determine whether irrigated agriculture could be successfully established on land which might be irrigated from a proposed dam." The main emphasis in trials has been with cotton, rice, safflower and linseed. Other crops have included sugar cane.

Yields obtained with cane have been high and have compared well with those obtained in Queensland. At least half a dozen varieties introduced from Queensland have grown well in the trials, including Pindar, Q57 and Comus (if planted early). Two ratoon crops are taken as standard practice at the Station. Fertilizer trials have shown that both ammonium sulphate and superphosphate are needed, 2 cwt of each being now applied to all crops as routine.

Irrigation data suggest that about 20 waterings, each of 3 inches, may be required each year. So far insect pests and diseases have not proved serious. Ratoon stunting disease has not appeared. Further agronomic trials are considered desirable but major research with sugar cane has been suspended until such time as a decision is made to produce the crop commercially. "There seems little doubt that sugar alone could form the basis of a successful irrigation development. A relatively small engineering scheme would suffice for the 12,000 acres of cane required to supply a mill of minimum economic size (45,000 tons per annum). This project would meet Western Australia's entire sugar requirements and produce a gross annual return of several million pounds."

F. N. H.

Agricultural Abstracts

Sugar cane root rot. K. V. SRINIVASAN. *Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 293–298.—Previous work on root rot and the fungi considered responsible is reviewed. *Pythium graminicolum* was found to be the most common cause in India in all soils examined, except one in Taliparamba. Symptoms of *Pythium* root rot and *Rhizoctonia* root rot were distinct. With extended cane cultivation to marginal lands and heavy soils with high soil moisture it is considered more attention should be paid to sugar cane root rot.

* * *

Reaction of some sugar cane varieties to smut. N. J. AHMED and K. SAMBASIVAM. *Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 299–301.—Smut (*Ustilago scitaminea*) is considered to be the most serious disease of cane in Madras State. The results of artificial inoculation experiments, from 1955–62, on different varieties are given. Many high yielding varieties are very susceptible but there are some varieties that have good agronomical characters combined with moderate resistance, notably Co 658 and Co 785, which are in the extended field trial stage. Dry weather during tillering is believed to encourage the disease.

[1] *Producers' Review*, 1964, **54**, (2), 13–15.
[2] *See also I.S.J.*, 1964, **66**, 136.

THICKHEAD—A WEED THAT NEEDS WATCHING

THIS is the title of a leaflet by S. L. EVERIST[1] about a weed, relatively new to Queensland, which has spread considerably since its first appearance eight years ago and which has "become abundant in some pineapple and sugar cane crops, particularly around Nambour."

This plant (*Crassocephalum crepidioides*, family Compositae) is a native of eastern Africa and Madagascar and has been a common weed in Indonesia for many years. In Queensland it occurs mostly in disturbed or unused land such as roadsides, footpaths, new scrub or forest burns, cultivation headlands, creek beds or eroded banks. It has shown no tendency to invade good pasture. The plant has soft, upright leafy stems with a few orange-red bell-shaped flower-heads near the top and large bright green, deeply divided leaves. The small 'fluffy" seeds (with a pappus) are blown about readily by the wind. The plant appears distasteful to animals but there are unconfirmed reports of its tainting milk. It is not known to possess toxic properties.

With regard to control the plant is reputed to be resistant to hormone weedkillers such as 2,4-D and 2,4,5-T. These curl up the tips of leaves and branches but the plants soon recover and eventually produce just as many seeds. However the plants are extremely sensitive to sodium chlorate and spraying with a weak mixture (1¼% w/v) gave complete kills. "Diquat" also kills the weed readily.

This species is not uncommon as a wild plant in some parts of East Africa, notably Kenya and Tanganyika. A study of herbarium sheets shows that it has been collected, in fact, quite near Nairobi and has been described as a weed in East Africa in wheat and in cultivated ground generally. Under favourable growing conditions it reaches 3 feet in height and has been described as having, somewhat, the appearance of outsize groundsel (*Senecio vulgaris*). The flower-heads are nodding in the bud stage, becoming erect later. It would seem that the name thickhead is one which has been coined or adopted for the plant in Australia.

F.N.H.

[1] Advisory Leaflet No. 735, Division of Plant Industry, Queensland Dept. Agric. and Stock.

AGRICULTURAL ABSTRACTS

Marasmius **disease of sugar cane in Uttar Pradesh.** K. SINGH and M. M. TIWARI. *Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 302–305.—A serious outbreak of the disease in a district of Uttar Pradesh in 1960 is outlined. Laboratory culture experiments are described with a table showing how the organism differs from *Marasmius sacchari* and *M. stenophyllus*, the established causes of basal stem, root and sheath rot.

* * *

Australian sugar cane varieties in India. J. T. RAO *et al. Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 306–310.—This is the second article of the series "Notes on foreign cane varieties", the first having dealt with varieties bred in the U.S.A. The performance in India of leading Australian bred varieties is described. This has not been outstanding, probably because of different climatic conditions, but it is thought some may be useful in breeding work.

* * *

Fertilizer response on sugar cane in Rajasthan. C. J. JAISINGHANI and S. V. JAIN. *Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 311–314.—Sugar cane is an important cash crop in the State, occupying about 8000 acres, an area likely to increase with new irrigation projects. Experiments on three different types of soil are described. All needed N and P. Two showed no significant response to K.

* * *

Frost damage to cane—a guide for growers. ANON. *S. African Sugar Exp. Sta. Leaflet*, 1964, 2 pp.—This leaflet was issued as a guide to sugar farmers who found their crops affected by frost during the exceptionally cold winter conditions that prevailed during July 1964. Four main categories of cold injury in cane are recognised and described. These vary from killing-off of the exposed leaves only, from which the plant soon recovers, to spindle leaves, stem apex and eyes being killed. This leads to rapid fermentation and rotting of the main stem. Such cane must be given priority for cutting. Farmers in frosted areas are warned to take special care in selecting seedcane and to make sure the eyes are sound.

* * *

A study of press-mud and compost as a medium for raising sugar cane seedlings. S. A. AKHTAR *et al. Indian J. Sugar Cane Res. Dev.*, 1964, **8**, 350–351. A mixture of press-mud (sulphitation) and compost proved satisfactory in raising sugar cane seedlings, in place of gritty sand plus powdered horse manure usually used. With increased mechanical transport horse manure is not so readily obtained as formerly.

* * *

New cane lands problems. ANON. *Producers' Rev.*, 1964, **54**, (6), 33–35.—Remarks made by the Director of Sugar Experiment Stations, N. J. KING, in an address at the Meringa Field Day are recorded. It is not expected that the large intake of new cane land will give rise to any major agricultural problems. Nevertheless a careful watch will need to be kept on pests and diseases, the question of cane varieties and on nutrition. It should be remembered that some cane pests are indigenous and occur in forest and grass lands.

Louisiana's 1963 sugar crop set some new records. G. J. DURBIN. *Sugar J.*, (La.) 1964, **26,** (11), 52. Average yield of cane for the State for 1963 was 28·5 tons per acre. Records (going back to 1901) show the previous "high" was 26·0 tons in 1904, followed by 25·7 tons in 1961.

* * *

Notes on residual fertilizer. C. R. VON STIEGLITZ. *Producers' Rev.*, 1964, **54,** (6), 44.—Residual fertilizer is described as the amount of fertilizer in the soil which remains as an excess to the requirements of the crop for which it was applied. The transient nature of nitrogenous fertilizers is emphasized. This is well illustrated by the fertilizer programmes in sugar cane cultivation. For it is common knowledge that where nitrogen is not applied to ratoon crops a reduced yield can be anticipated if moisture conditions are sufficient to ensure normal growth. With high rainfall or irrigated conditions cane crops are unlikely to reap benefit from excess nitrogen applied to a previous crop.

* * *

Grubs in South Queensland cane fields. ANON. *Producers' Rev.*, 1964, **54,** (6), iv.—This is an account of an address by R. W. MUNGOMERY, at the Bundaberg Field Day, on methods of dealing with sugar cane borers or "grubs" with special reference to the correct use of soil insecticides. "Dieldrin" and "Heptachlor", so effective against soldier fly, are useless against "various species of white grubs" in south Queensland. Happily, crude BHC and "Lindane" are both effective against these pests.

* * *

Nutgrass. A. C. MAGALHAES and C. M. FRANCO. *Bragantia* (Sao Paulo), 1962, **21,** 53–58; through *Herbage Abs.*, 1964, **34,** 173.—As nutgrass (*Cyperus rotundus*) is one of the worst weeds of sugar cane in many lands, its apparent or alleged sensitivity to the root nodule extract of the sword bean (*Canavalia ensiformis*) may interest many. In a glasshouse experiment, the growth of nutgrass was considerably reduced when fresh extract of root nodules of the sword bean was added to the soil. A similar extract from roots without root nodules did not have this effect.

* * *

Variations in the number of cattle units able to utilize sugar beet by-products. J. SARTHOU-MOUTENGOU and J. CAZALA. *Al Awamia*, 1962, (4), 135–145; through *Herbage Abs.*, 1964, **34,** 168.—Calculations are made of the number of fodder units and protein equivalents given by the tops, leaves and molasses pulp expected as by-products from sugar beet with various yields of topped roots. These are compared with the area of dry-farmed berseem or irrigated lucerne required to furnish various cattle units with fodder.

New outlook needed on fertilizers. ANON. *Producers' Rev.*, 1964, **54,** (6), 39.—An address by L. G. VALLANCE of Sugar Experiment Stations at the Ayr Field Day is recorded. Emphasis is on the newer nitrogenous fertilizers, urea and anhydrous ammonia, their advantages and the precautions that are necessary in their use, especially adequate soil cover to prevent loss of ammonia gas.

* * *

On the nitrogen-potassium ratio in sugar beets and its influence on yield. H. LÜDECKE and M. NITZSCHE. *Zucker*, 1964, **17,** 173–178, 203–211.—This work was based on field trials, divided into 4 groups, viz. (a) where increasing amounts of N-P-K are applied—the N-P ratio remaining constant, (b) increased N but unchanged K; (c) increased K but unchanged N and (d) trials with very high nutrient supplies. The latter, especially with N, delayed maturation of sugar beet.

* * *

Recommendations for the control of Johnson grass seedlings and Johnson grass in Louisiana sugar cane. E. R. STAMPER and D. T. LOUPE. *Sugar J.*, (La.) 1964, **26,** (11), 50–51.—As yet there is no miracle chemical herbicide for sugar cane. Fallow ploughing is still necessary to control Johnson grass (*Sorghum halepense*) plants and rhizomes. This includes ploughing the land 6 or more times in spring and summer after the temperature is high enough for good plant growth. Recommendations are given for the correct use of a number of herbicides including "Fenac", TCA, "Dalapon", and "Silvex".

* * *

Problems of later weed infestation in beet fields. A. VON HORN. *Zucker*, 1964, **17,** 282–286.—Pre-emergence treatment with "Alipur" or "Pyramin" has no influence on the later appearance of *Galinsoga* weed (*Galinsoga parviflora*). Treatment after singling was found to prevent the appearance of *Galinsoga* until August or September.

* * *

A new blister mite on sugar cane in Taiwan. CHO-SAN WANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1964, (33), 83–94.—This mite, *Aceria sacchari*, is fully described. It lives inside the leafsheath and is widespread in Taiwan, on many cane varieties, but does not seem to harm cane.

* * *

Studies on chemical control of subterranean insects in ratoon sugar cane. Part I. Effect on wire-worm. S. T. LEE. *Rpt. Taiwan Sugar Expt. Sta.*, 1964, (33), 95–105. "Aldrin", "Dieldrin", BHC and "Aldrin"-BHC mixture, applied before planting, all gave significant control of wire-worm. A satisfactory and economical treatment is considered to be 2·5 lb "Aldrin" per hectare (i.e. 100 lb of 2·5% dust).

Insects that affect the sugar plantation in Peru. S. H. RISCO. *Sugar J.* (La.), 1964, **26,** (11), 82–84.—The writer gives the names of the principal insects that attack sugar cane in Peru with notes on each (about 18). The worst pest is the borer *Diatraea saccharalis.* Biological control with *Paratheresia claripalpis,* started in 1951, reduces intensity of infestation by 70%. Insect pests of cane are not as serious in Peru as in many other cane growing countries of the New World.

* * *

Migration in the soil of the sugar beet eelworm. F. J. LÖCHER. *Zucker,* 1964, **17,** 252–258.—The beet form of the stem and bulb eelworm or nematode (*Ditylenchus dipsaci*) was found in soil to a depth of 40 cm, but occurred mostly in the upper 20 cm. In spring and autumn, mainly spring, eelworms invade the beets. This may occur in two waves. Inactivity of eelworms in the soil in summer is believed to be due to the higher temperature.

* * *

Studies on nutgrass (*Cyperus rotundus*) **and its control.** C. CHANG and B. SEE. *Rpt. Taiwan Sugar Expt. Sta.,* 1964, (33), 1–16.—Under Taiwan conditions flowers of nutgrass are nearly all sterile, reproduction being by vegetative means. Tubers may each produce 4–5 shoots and are very tolerant of adverse conditions. Dormancy may extend to 10 years. Several herbicides gave some degree of control, the most economical being 2,4-D applied 3 or 4 times at the lowest effective rate (1·5 kg/ha).

* * *

On the root system of sugar cane in Taiwan. M. T. CHEN and T. C. LEE. *Rpt. Taiwan Sugar Expt. Sta.,* 1964, (33), 17–35.—Sugar cane root systems were investigated in 1954–58 by removing soil in measured layers, separating the roots from the soil by washing, and weighing the dried roots from each layer. Results are summarized. In poorly drained soils roots were largely confined to the top soil. High cane yield could not always be correlated with a deep and widespread root system.

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Downy mildew of sugar cane in Taiwan (Part VI). T. MATSUMOTO, P. C. CHEN and S. M. YANG. *Rpt. Taiwan Sugar Expt. Sta.,* 1964, (33), 53–62.—Further studies on the relation of environments to sporulation are reported. The production of spores by this fungus (*Sclerospora sacchari*) is dependent upon high atmospheric humidity (not below 86%) and temperature (23°–31°C), the range of humidity favourable for sporulation being much narrower than that of temperature.

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Nematode investigation in sugar cane fields in Taiwan. C. H. HU and H. T. CHU. *Rpt. Taiwan Sugar Expt. Sta.,* 1964, (33), 63–82.—Further investigations of nematodes in different sugar cane soils in Taiwan are reported. Besides the 9 genera of parasitic nematodes already reported, 7 more genera were discovered and are listed. Infestation varied from 3·8% to 65·2% and seemed to be associated with soil type, lateritic soils giving the highest counts.

^{15}N-nitrogen field studies with sugar cane. D. T. TAKAHASHI. *Hawaiian Planters' Record,* 1964, **57,** 198–222.—It is pointed out how the availability of the radio-isotope of nitrogen (^{15}N) has provided a practical tool for study of the utilization of nitrogen fertilizer by a cane crop in the field. In experiments in Hawaii one-third of the fertilizer nitrogen was recovered in the entire cane plant, including discarded leaves. Substantial amounts of N remained in the soil for subsequent ratoon crops.

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Effect of lime and hog manure on sugar cane yields. T. P. YEH. *Rpt. Taiwan Sugar Expt. Sta.,* 1964, (33), 135–152.—Results are given of an experiment, extending over the period 1953–1962, of liming and of continuous application of manure composts on sugar cane yields. A probable increase of 5% was attributed to 20 tons of compost per hectare.

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Histological examination of sugar cane. T. TANIMOTO. *Hawaiian Planters' Record,* 1964, **57,** 119–132.—The distribution of fibrovascular bundles ("fibre") in the cane stem is discussed and illustrated with photomicrographs. An interesting series of photographs shows daily development of the growing point in the sugar cane stem during the period of tassel-bud initiation (flowering).

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Tissue and cell cultures of sugar cane—another research tool. L. G. NICKELL. *Hawaiian Planters' Record,* 1964, **57,** 223–229.—Fourteen different fields of investigation, with sugar cane, that might benefit from recent developments in cell and tissue techniques are outlined. These include nutritional and growth studies, mutation, irradiation response, pathology and virology or virus disease studies.

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Arginine: its role in sugar cane growth. L. G. NICKELL and H. P. KORTSCHAK. *Hawaiian Planters' Record,* 1964, **57,** 230–236.—The nutritional value of the amino acid arginine as a source of nitrogen for sugar cane is discussed. It is found free in trace amounts only, if at all, in cane juice and molasses.

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Studies in the drought endurance capacity of cane varieties. S. SINGH. *Indian Sugar,* 1964, **13,** 717–720. A method of estimating drought resistance by growing setts individually in pots in a greenhouse is described. A sunflower plant was grown in each pot and removed when permanent wilting occurred. Five varieties of cane were used in the experiment. It is thought the method might be helpful in assessing the drought endurance capacity of a new sugar cane variety.

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Cane varieties in Peru and breeding in Haciendo Laredo. P. TERESHTCHENKO. *Sugar J.* (La.), 1964, **26,** (12), 22–24.—The variety situation in Peru is discussed, including importations from Hawaii under trial. About 14 locally bred varieties which show promise are dealt with. Of these La. 52-604 now occupies 16·5% of the total cultivated area of Laredo.

The history of sugar estates in Mauritius. G. ROUILLARD. *Rev. Agric. Sucr.*, 1964, **43**, 5–21.—Information on the evolution of the sugar industry in Mauritius, with a detailed map, is given.

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The economic development of the Mauritius sugar industry. R. LAMUSSE. *Rev. Agric. Sucr.*, 1964, **43**, 22–38.—This, the first of a series of articles, is concerned with development in the field and factory, the evolution of the agricultural labour force, the sources of the system of crop finance and the world sugar market. The work was originally prepared as a university thesis.

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Locust cane pests in Mauritius. J. R. WILLIAMS. *Rev. Agric. Sucr.*, 1964, **43**, 39–50.—General information on the migratory locust (*Locusta migratoria*) and the red locust (*Nomadacris septemfasciata*), both cane pests in Mauritius, is given.

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Sugar beets in W. Pakistan. ANON. *Sugar J.* (La.), 1964, **26**, (12), 24–25.—Reference is made to the Charsadda sugar factory in West Pakistan which has been successfully processing sugar beet as well as cane since 1961, additional machinery for the slicing and diffusion of sugar beet at the rate of 1200 tons a day having been installed. Beets are processed after the cane and give 25–35% more sugar to the factory. Two more similar conversions of existing cane factories are proposed.

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Sugar cane in Southern Rhodesia. A. C. BARNES. *Sugar J.* (La.), 1964, **26**, (12), 32–33.—An interesting historical account of sugar cane cultivation in Southern Rhodesia, which is of comparatively recent origin, is given. Porous soils render overhead irrigation desirable.

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Fertilizer recommendations for sugar cane in Louisiana for 1964. D. T. LOUPE. *Sugar J.* (La), 1964, **26**, (12), 37.—Rates of application of N, P and K fertilizers for the different soil types in Louisiana are made, for both plant cane and ratoons. Where pH is less than 5·5 liming is recommended (2 tons ground limestone per acre). Liming increased yields of soybeans and clovers.

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On the bunch planting method of testing sugar cane seedlings. P. Y. JUANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1964, (34), 19–30.—The technique of planting sugar cane seedlings in bunches of 5 to 25 and later selecting those with the best looking stalks has been much used in Hawaii. The bunch planting method is considered useful in Taiwan in selecting the strongest or most competitive and vigorous growing seedlings.

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The effect of sanding non-irrigated clay soil on sugar cane yield. L. H. LEE and Y. S. CHAN. *Rpt. Taiwan Sugar Expt. Sta.*, 1964, (34), 31–55.—Improved growth of green manure plants and of cane is well demonstrated by photographs. Normally sanding is regarded as too expensive for field crops but the population explosion and demands on agricultural land may make it economical.

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Fighting fires in sugar cane. B. J. WILKES. *S. African Sugar J.*, 1964, **48**, 439.—The need for understanding the theory of fire fighting is stressed. Correct location of the "chimney" before putting in a "back burn" is emphasized. Recent experience with Zululand cane fires has proved the futility of vast hordes of badly disciplined workers at a fire; it is far better to have a dozen or so well-trained, fit individuals obedient to authority.

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Flowering in sugar cane. P. G. C. BRETT. *S. African Sugar J.*, 1964, **48**, 443.—Conditions that favour the flowering of sugar cane under South African conditions are discussed in a popular manner. It is pointed out that although flowering may not be desired by the cane grower it is essential to the cane breeder.

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Transportation of sugar cane and plantation timber. P. R. HILL. *S. African Sugar J.*, 1964, **48**, 469–481. Records show that transportation of sugar cane from field to mill in South Africa represents 8·5% of total production costs. Much of the harvesting takes place under unfavourable weather conditions when getting cane out of the field is difficult. General haulage problems are discussed and the rôle of the tractor as a prime mover, especially when linked to a power-driven trailer (power supplied by tractor to trailer wheels). Transportation costs and tractor/trailer costings are given with 5 tables.

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Co 740 under test. ANON. *S. African Sugar J.*, 1964, **48**, 481.—Undue publicity has been given in the press to this Indian variety, still in quarantine in Natal. It is not known yet how it will behave under Natal conditions.

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The 4-year research programme of the Taiwan Sugar Experiment Station. K. C. LIU. *Taiwan Sugar Quarterly*, 1964, **11**, (1), 9–15.—Attention is drawn to the fact that cane growing in Taiwan differs markedly from that of most cane growing countries with the average size of peasant cultivator's holding only 1 hectare and of his family 7—hence the necessity for intercultivation of cane with other crops, notably food crops. This affects the cane agronomy research programme.

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Nematodes as a factor in sugar cane varietal decline in Florida (a preliminary report). J. A. WINCHESTER. *Sugar J.* (La.), 1964, **27**, (1), 16–20.—An account is given of a nematode survey of Louisiana sugar cane soils during 1962–63. Large numbers of nematodes, belonging to 9 different genera of nematodes were found but only some have so far been proved to attack sugar cane. Reasons are given why it is thought nematodes play an important part in sugar cane varietial decline in Florida.

ASPECTS AFFECTING CONGLOMERATION

by H. E. C. POWERS

Address presented to the Swedish Sugar Corporation Conference, Malmö, 1964.

WITHOUT doubt pan boiling is the most important of all sugar factory or refinery operations. For generations sugar boilers or pansmen have been the skilled and privileged artisans of the industry. How should their merit be judged or the skill of individual pansmen rated? Further, how should the merit of any individual pan be rated, since the efficiency of the best of pansmen is still limited by the plant with which he has to work.

What might be called the engineering approach aims primarily at efficient and economical production, whilst the scientist's responsibilities lie also in the direction of quality of production. These viewpoints are not always in harmony, and overall direction should endeavour to preserve a happy balance. Crystallization, whether in pan or elsewhere, offers *par excellence* the simplest means of separating sugar from the natural impurities associated with it, whether in the natural juices from the plant or in the raw sugar as received at the refinery. This is the primary demand from the operation, i.e. that it shall be carried out in such manner as to permit the highest efficiency in separating sugar from impurities. Coupled with this is the demand that the crystals produced shall be as nearly as possible of optimum size and appearance. Even a little consideration will confirm that the shape of the individual crystals will be a significant factor in both of these demands. Well formed single crystals with axis ratio approaching 1:1:1 will have the minimal surface area and number of contact points per unit weight. They will hence most completely part with the impure mother syrup when centrifugalled. They will also best present the clean sparkle indicative of the reflection of light from the multiple crystal facets. At the other extreme, and worst of all, will be badly conglomerated sugar in which a layer of impure syrup inevitably remains between every adjoining pair of crystal facets, giving the sugar a darker and duller appearance, a lower purity, and a lower bulk density. Increased washing in the centrifugal merely reduces yield without effectively remedying the evil.

This being generally accepted, one might ask:

(1) How prevalent is conglomeration and is it possible to eliminate it?

and (2) Is it the fault of the pan design or of the pansman's technique?

Personal examination of large numbers of sugar samples, both raw and refined, from all parts of the world has shown that practically no commercially-produced sugar is free from conglomeration. By far the greater number of samples examined contained a high proportion. Raw sugars on the whole are very much better in this respect than refined. Among the refined samples examined, as a group those from India appeared to exhibit least conglomeration, only excepting certain other special sugars which will be referred to later.

This answers the first of our questions: conglomeration is very prevalent, but it certainly should be possible to keep it down to a very low proportion of the crystals.

To consider the influence of pan design, one must recall that pan design has been gradually evolved over a century or more. Quite understandably the main emphasis has been upon decreasing the cost of production per unit of weight, and this inevitably leads to the acceleration of boiling time and cycles, to increasing size of pan unit, and hence to problems of circulation. In these directions the advance has been quite remarkable, and only recently has it become apparent that in certain respects a price has been paid for this advance. Post-war developments in bulk handling and in packaging have spot-lighted some of these penalties, and we are now looking into possible ways of moderating these.

The most promising investigations into pan operations have been those wherein better circulation is assisted by other than self boiling movement. Years ago I received samples of refined sugars from A. L. WEBRE which demonstrated that his mechanical circulation system could produce excellent, almost conglomerate-free, sugar. It is perhaps fair and instructive to record also that at a later date I received more samples from the same pan which were far from good. Discussing this with WEBRE he quite justifiably pointed out that unless operators continued to adhere to the procedure advised by him, then the advantages might well be thrown away.

More recently I have found equally excellent grain characteristics in samples from pans using injected steam. This also aids circulation adequately, but practical difficulties, or rather penalties, have led to the steam injection method falling into disfavour and to increasing use of mechanical mixing.

Having referred to the long period of evolution of pan design it may be of interest to report that I have been able to examine grain from a very old pan of "onion" shape and found it completely different in characteristics, easily distinguishable from that from a typical modern designed pans. The grain was regular and elongated, i.e. much longer axis ratio than normal, and the surface when viewed under the microscope showed very strongly marked layer growth in a series of "contoured hillocks".

So much for the influence of pan design. Now regarding the pansmen, as has been recorded, as a class they are the highly skilled craftsmen of the industry, but inevitably some are far more expert than others in avoiding conglomeration. The continual pressure towards higher speed of throughput does in itself take much of the desirable freedom of

action away from the modern pansman. Instrumentation now offers the facility of automatic control of pan boiling, which should greatly diminish the variability of a sequence of boilings in the same pan. But the p esent pans have been evolved to suit the requirements for the human pansman, and we must expect the need for further moderation before the full possibilities of automatic control can fairly be judged.

Nucleation and agglomeration

Realizing, some ten years ago, that to attain real advance we needed to know much more about the mechanisms and the physics of crystal growth, I initiated some studies of the subject which have been reported at various times. In practice the actual formation of a new crystal—i.e. homogeneous spontaneous nucleation—is relatively so rare an event that we can omit it as a factor. Practically all our crystals originate in one of two ways, either

(1) from fragments of pre-existing crystals broken off by movement, or added deliberately to initiate grain, or

(2) from multimolecular sucrose aggregates (crystal precursors or embryos), again torn from the growing crystal surface during boiling.

Production and development of the latter is largely controllable by pan design and technique of operation, and can be catastrophic if not well controlled. A pan being "blinded with false grain" is an example of bad control.

If the nucleation takes place in the second manner at too high a supersaturation, then the nuclei may be largely spherulitic, this being a form of multi-crystal cluster, much to be deplored in sucrose boiling owing to its excessive agglomeration defects.

Perfect pan boiling should theoretically start with the desired number of true crystals at seeding time, no further addition being permitted at a later stage. In fact, to express the strict practical truth more accurately, vast numbers of embryos and submicroscopic crystals will inevitably be formed throughout the boiling, but with good boiling technique these may be prevented from developing into macroscopic crystals, by taking advantage of their higher solubility. If they are permitted to grow to larger size they will become increasingly difficult to eliminate since their solubility will become equal to that of the larger crystals. For practical purposes one may consider all crystals above 10μ to be equally soluble and therefore not amenable to this means of removal.

Now agglomeration may take place among crystals during boiling, when two or more growing crystals making contact are "sealed" together, before again being parted by the movement which brought about their initial contact. This tendency is naturally more marked when there is a heavy or close packed grain population concentration. I have never seen any evidence of crystals coming together by mutual attraction, and successful sealing of two crystals in a supersaturated solution appears to be accomplished more freely when the crystals have grown too large to show much influence by Brownian movement due to molecular bombardment. This then is a "danger zone" for later agglomeration.

When one considers the situation as two crystals make contact, at first sight it is somewhat surprising that they can so "grow together". Let us try to visualize what happens. Every crystal growing in a supersaturated syrup is surrounded by a "sleeve" wherein the supersaturation is lower than that of the surrounding syrup, owing to the continual deposition of sucrose molecules onto the growing crystal. Thus the two sleeves of the crystals approaching one another would merge, and growth rate might be expected to fall off progressively as the thickness of syrup between them decreases, until at actual contact the decreased supersaturation might well be unable to provide the necessary quantity of molecules to affect a lasting bond, unless the two crystals remained in contact long enough to permit adequate diffusion. They might be expected to drift apart without sealing. In fact I am of the opinion that there is another molecular activity on the surface of the growing crystals which aids cementation at and around the point of contact. Partially bonded molecules are moving or sliding freely over the crystal surface until they become permanently anchored in the lattice, these forming a sort of "fluidized" surface, a potential cementing material drawn from farther surfaces of the crystal unshielded by the contacting surfaces. It is this fluidized layer which makes possible the development of the regular geometric shape of crystals, being able to respond most readily to the complex fields of attraction around a growing crystal. It facilitates free growth of the crystal into that form or "habit" ordained by that particular molecule.

You will see that when we analyse pan boiling operations even from the point of view of a few growing crystals we find a complex picture, even though I have already simplified the position and eliminated a great deal of detail less pertinent to our primary subject of conglomeration.

An ideal production cycle

We must be prepared freely to alter our pan designs in the future if we wish to attain predictably uniform and satisfactory successive boilings by automatic control. A good start would be to accept the fact that the pan handling fifty tons of massecuite cannot be the ideal design for producing the most desirable seed grain, of which only a few pounds weight are required. The sugar man should be no more ready to use "any old seed" than is the good farmer. Seed grain should be near perfect in habit and structure, with optimal layer growth surface. I have indeed the feeling that we might well apply the terms "pedigree" and "inheritance" to our thoughts on optimal seed production. Such seed would be produced in specially designed pans under

skilled laboratory control, being only required to produce maybe fifty pounds weight, or less, of crystals upwards of 10 microns in length. Each batch should pass a rigorous test before acceptance for use.

Transferring this seed magma to the pan should be on the basis that the right number of crystals would be taken into the pan, and these only, grown to the desired size, should be produced. False grain intrusion should be eliminated by correct control of the degree of supersaturation of the syrups at all points. Differential solubility of grain has in the past helped the sugar man enormously without his realizing its existence in most cases. We should design to make full and intelligent use of it in the future.

To illustrate my thesis I will try to indicate the order of supersaturations desirable. The initial pan charge into which the seed magma is introduced should be between 1·0 to 1·05 superaturation, both being of the same temperature. A designed cycle time between the heating and the evaporating zones would be arranged such that nuclei produced by movement would be dissolved at the heating zone before it had grown to micron size. Thus the main grain may continue growing at all stages, unless it is found desirable to submit it to slight surface erosion in order to develop more efficient layer growth by the recession layer development of very slight dissolution. At no time should supersaturation be allowed to get too high—maybe 1·4 supersaturation might be too high but this can only be determined on the plant. As has been said, the charge as dropped should have about the same number of crystals present as were in the seeding charge.

Dropping from the pan entails some shock, so supersaturation should be kept down at dropping point, probably best by rise in temperature. The receiver crystallizer should be at the same temperature as the charge. Nucleation at this transfer stage might lead to some extremely fine grain lightly adhering to the surface of the main grain—a special form of conglomeration—and it would also increase the proportion of ultrafine grain present.

The masse should be cooled in motion, only at such speed that the grain can take up the molecules, as in the pan, without causing further false grain generation, this bringing the whole pan charge to uniformity probably at about 1·1 to 1·15 supersaturation. A heater in the pipeline to the centrifugals should reduce this to 1·0 to 1·05 superaturation in order to gain the lower viscosity without dissolution. Need for washing in the centrifugal should then be minimal, since the grain form should be near ideal. Caking on the sugar face in the centrifugals should be minimized; this is due to air being forced through the sugar wall by the centrifugal force, and may be countered by raising the humidity of the air.

Drying with gentle motion should be carried out in an atmosphere of never lower than 50 relative humidity, only slightly warmer than the sugar in first stage, cooling off in last stage. This should avoid the too hurried drying of the sugar which results in some of the surface syrup finishing up as a glaze, and hence should minimize later problems of caking during maturing in store.

The above ideal cycle obviously calls for a considerable amount of further study by all parties. Particularly is the need evident for multi-point indicators (even better, recorders and controllers) of the degree of supersaturation at all pertinent points, not only at one or two points in the pan. Pan design may well be radically changed. There is the ever-present challenge to develop continuous production, a challenge which might become even more insistent if more uniformity were required. Batch production perhaps lends itself more readily to catering for fluctuation in output rate and type.

From the scientist is required very much better understanding of the mechanics of nucleation and growth. We do not yet know what is the ideal seed. Oddly enough we now know that an absolutely perfect crystal could not grow. Imperfections or faults are essential for growth, and variations of these in different crystals lead to a great deal of individualism in the growth of each crystal. I think it probable that in our future operations we shall know how to develop optimum faults to aid our commercial production.

I would like to see thorough investigations of the sleeves of exhaustion of systems of crystals growing in differing intensities of movement and density of grain population and also of nucleation at different supersaturations under the influence of different modes of induced movement of the massecuite. From my own studies I am inclined to think that the impulse should be such as to induce maximum streamline and minimum turbulent flow. The former would tend to favour smooth flow of the suspended crystals through their cycles of high and low supersaturations, with minimal nucleation. The answer can only be obtained by practical experiment, however. J. MULLIN has confirmed my finding that intensity of nucleation rate increases with increasing rate of movement at moderate rates but he finds that at higher rates the nucleation rate may even fall off, presumably owing to mechanical breakdown of the embryos themselves under higher stresses. If this analysis of the desirable fluid movement and conditions during the boiling cycle is correct, then the varietal zig-zag path of the conventional continuous production systems appear perhaps more logical than the present pans designed for batch work.

It might also be mentioned that, as reported in *Socker Handlingar II*, 1963, **18,** 29–83[1], the teams of investigators enquiring into the explosion in Sweden found that one of the major contributory causes was conglomeration of grain which led to greatly increased breakage and hence dust formation. It is therefore highly desirable to minimize conglomeration in the production of refined sugars.

[1] *I.S.J.*, 1964, **66,** 361.

IMPROVEMENT OF WHITE SUGAR CRYSTAL QUALITY IN VACUUM PANS

By T. RODGERS and C. L. LEWIS

Paper presented to the 17th Tech. Conference, British Sugar Corporation Ltd., 1964.

PART III

Massecuite Velocity

A test was made last campaign at King's Lynn to ascertain the possibility of measuring with reasonable consistency the massecuite velocity in the heating tubes. If this proved possible, it was hoped to extend it to various designs of pans in the future, to be able to judge efficiencies of different designs of propellers. A knowledge of this velocity would be of the utmost importance, as it would give an indication, not only of the rate at which heat is borne away from the heating surface into the masse above—thus reducing the bad effects of local over- and under-supersaturation—but also of the "turnover" rate of the whole contents of the pan.

The procedure adopted is illustrated by Fig. 11. The measurement is made by conductivity using a "Cuitometer." The sensing element is a 37/0076 wire insulated with P.T.F.E., the wire being bared over part of the diameter of the tube top in which the velocity is to be measured. The tubeplate is drilled and tapped to secure the wire which is threaded between the tubes to reach the circumference. The wire is brought through the pan wall using a small gland. The second terminal of the "Cuitometer" is connected to the side of the pan. A small bore tube, with fittings all $\frac{1}{2}$-in B.S.P., is taken through the pan wall below the bottom tube plate and ends, as shown, with a $\frac{1}{2}$-in B.S.P. bend pointing up the tube and approximately flush with the bottom of tube. The outside end has a funnel, valve, and a steaming connexion.

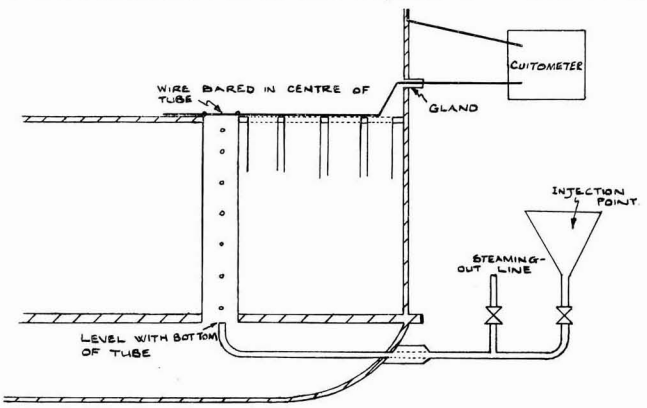

Fig. 11

The most successful technique was to inject a solution of molasses at the same temperature as the massecuite in the pan and diluted to approximately the same viscosity under these conditions. As the funnel valve was opened, a stop watch was started, and the time elapsed before a "kick" on the "Cuitometer" was noted. The velocity calculated in this way gave quite consistent results, and similar tests will be made on

Table V

	Stirrer power (h.p.)	*Steam used evap. stage*	*Pan vacuum (in Hg)*	*Masse quantity (hl)*	*Dry subst. (%)*	*Tube Velocity (ft/sec)* *stirrer + steam*	*stirrer only*	*steam only*
TEST NO. 1.	33·5	2nd	25·0	140	84·3	2·15	—	—
	34·5	2nd	23·5	240	87·6	2·15	1·94	0·36
	44·0	2nd	22·5	280	91·6	1·41	1·45	0·35
	40·0	1st	23·0	310	90·8	1·18	—	—
	60·0	1st	23·5	320	92·9	0·68	—	0·18
TEST NO. 2.	33·5	2nd	25·0	140	83·4	1·55	—	—
	33·5	2nd	25·0	180	87·4	1·55	1·40	0·31
	36·0	2nd	25·0	250	90·3	1·02	—	—
	36·0	1st	25·0	250	90·3	1·36	—	0·33
	40·0	1st	25·0	320	91·1	1·33	—	—
	60·0	1st	25·0	330	93·2	0·94	—	0·24
TEST NO. 3.	35·0	2nd	22·0	140	—	1·46	Before Graining	
	33·5	2nd	21·8	140	—	1·63	After Graining	
	32·0	2nd	20·5	160	—	1·51	Continuous Feed	
	32·0	2nd	21·5	180	84·8	1·58	,,	,,
	33·0	2nd	21·5	200	85·6	1·33	,,	,,
	33·5	2nd	20·5	220	85·8	1·38	,,	,,
	36·0	1st	22·0	280	91·0	1·33	,,	,,
	50·0	1st	21·5	320	92·4	1·33	,,	,,

various installations next year, especially to compare the effects of pan shape, tube diameter and downtake diameter. Table V summarizes the results. The tests were curtailed because the wire became loose.

Column 2 records the steam used in terms of the evaporator vapour used. In this case, 2nd Vapour is about 11 p.s.i.g. at the evaporators and 1st vapour approximately 20 p.s.i.g.

Apart from the reasonable consistency of the results, the very significant factor is the improvement in velocity provided by the stirrer. As an average result, the velocity is four times the natural circulation velocity. It is also interesting to note that, with the steam shut off, there was very little decrease in tube velocity so long as the stirrer was in use.

The increased velocity is considered a very important factor in the improvement of crystal formation, although in itself it does not tell the full story. The lack of true circulation in pockets, especially near the pan wall, can still remain, and have a bad effect on good sugar production. The fact that the propeller can maintain a good circulation without the aid of water evaporation is also a very important fact from the point of view of "bringing together" the initial grain without excess use of water.

Automatic Control of Boiling

Mention has already been made of the possibility of the sugar boiling technique affecting the success of present installations. These techniques are not, however, always easily changed in a short time, and with new installations already going in, we want to ensure as much gain as possible from them in the shortest time. To do this, we can adopt two measures:

(*a*) incorporate, as far as possible, into the new installations all the points of design which have proved or are thought to be beneficial.

(*b*) eliminate, where possible in the boiling technique, the judgement of the individual in deciding on certain important variables.

The first measure will be discussed in the next section, but the latter really means that we should provide a scheme of automatic control for boiling the pan. When the best programme is found—and this may vary a little between factories, and indeed between individual pans—this can be pre-set on the instruments and the best results obtained from the particular pan, related of course with a consistent sugar. A control method has been decided, and it is proposed to install this in the 1964/65 campaign on one pan at Cantley factory.

In deciding on the method, acknowledgement must be made of two excellent papers that have been produced within the last few years, one by Dr. G. Genie[4] of Tirlemont and the other by J. G. Ziegler[5] of the Taylor Instrument Company, in the U.S.A. At the same time, for the method to work satisfactorily, good circulation of the massecuite is essential, and this can only be produced by mechanical means.

Two fundamental conditions of the boiling have got to be controlled.

(a) The mobility of the massecuite, and by this we mean the concentration of crystals in mother syrup at all stages of the boiling. The mean distance between individual crystals must never become too great, otherwise there is a great danger of producing fines and conglomerates when the pan is "brought together."

(b) The supersaturation of the mother liquor. Again this must be kept as high as possible without forming false grain, so that the boiling will be completed in the shortest time.

It is proposed to control (a) by measuring the power required to drive the circulator, and to use this signal to control the rate of liquor entering the pan. It is fortunate that the stirrer power in any particular pan appears to be a function only of the mobility and is independent of the amount of massecuite in the pan (see Figs. 5 and 6).

To measure (b) is not so simple, and several procedures have been described in the past. The difficulty is that the supersaturation at any point is always affected by varying head of massecuite above that point, with its further effect on the boiling point elevation. To overcome this, we propose to control the absolute pressure of the pan within very close limits, by use of a pressure controller actuating the condenser water valve. The actual value of this pressure is not important so long as it is within present reasonable limits, but it is important to control pressure variation within a very narrow range. The position of highest supersaturation in the massecuite, provided circulation is good, is at the surface, where the temperature is lowest. By measuring the amount of superheat, therefore, in the vapour liberated from this surface, we can calculate the supersaturation of the mother syrup at this position, and if we eliminate eddy currents in the masse, this supersaturation value will not be exceeded elsewhere. This value of supersaturation will then control the valve admitting steam to the pan, and so maintain the correct evaporation rate for syrup being admitted by the signal from the mobility meter.

This is the fundamental control which we hope will produce good and consistent crystals.

Additionally, we can provide a level control which will automatically charge the pan, and shut it off when full. The supersaturation meter can also be made to introduce the seeding charge at the appropriate moment. It is quite feasible to automate the whole process, but at the moment our main desire is to be able to obtain the optimum results from each pan installation, coupled with consistency.

The whole boiling procedure will then be as follows:

Vacuum will be applied to the pan, the charge of liquor pulled in and its amount controlled by the

[4] *I.S.J.*, 1962, **64**, 232–236, 260–264, 298–300.
[5] *J. Amer. Soc. Sugar Beet Tech.*, 1963, **12**, 462–467; *I.S.J.*, 1964, **66**, 231.

level controller. When the charge is complete the stirrer may be started and the steam valve opened. At this stage the pressure controller will be in operation, but the temperature instrument will, of course, be well under its control point, as the concentration, and therefore superheat, in the vapour will be low. As the juice boils down, the level controller will admit more juice to maintain the charge level. As the concentration reaches the supersaturation suitable for graining, the temperature will increase, until at the desired point the fondant seed will be drawn into the pan. Care will have to be taken at this point to avoid drawing in air also, as this could induce false grain, while our effort should be concentrated on only having those grains present which come from the fondant.

It should be recalled that with full seeding it is not necessary to get as high a supersaturation in the pan as with shock seeding. It should not therefore be necessary to use the normal boiling practice at this stage of quickly reducing the supersaturation either by water, a large "drink" of juice, or an increase in absolute pressure. For the same reason there will be no initial increase of power on the stirrer (as shown in Fig. 5), so that after graining the juice valve will remain closed until the crystals have grown to the desired mobility. The steam valve will be nearly closed at first, as the supersaturation is decreasing only very slowly as the sucrose first crystallizes at a very low rate. However, as crystallization proceeds, the juice valve will gradually open, and this in turn will introduce more water to the pan, thus reducing the supersaturation, which will be compensated by the temperature bulb increasing the steam valve opening. Boiling will proceed on these lines, until the pan is full, when the level controller will override and shut the pan off. When the mobility and supersaturation has reached the end values, the pan will be dropped.

It is intended to fit a pan microscope so that the crystal growth can be followed.

Future Installations

Further stirrer installations are planned for the 1964/65 campaign. There will be five factories, including King's Lynn and Cantley, where all white pans will be equipped with stirrers. The same five have also got sugar silos. One 2nd product and one after-product pan will also be fitted for the first time. On after-product it is hoped to achieve the same extraction of sugar from the low purity mother liquor in much less time, owing to the relatively faster movement of crystals in the liquor. It may even result in a lower purity of the final molasses, using existing equipment.

Good quality crystals from the 2nd product boiling—especially when magmatization of after-product sugar is operated—is one of the most important factors in first-class white sugar production. The sugar must be easily cured in the centrifugals, and there is every reason to believe that a stirrer will perform the same improvement with the second product as it has with the first.

Further information is to be collected in this campaign on massecuite tube velocities, and modifications are being made on individual propellers. The position of the liquor feed inlet is probably more important than has been previously considered, and further information is sought on this question. Likewise, with full seeding, at a fixed supersaturation, it is important that the fondant seed be evenly dispersed as quickly as possible in the supersaturated liquor. Our information at present suggests that the best way to do this is to admit it on the suction side of the propeller, i.e. in the centre downtake. It is hoped to find out something more about the problem in this off-season refining.

There is no doubt that the stirring of white massecuite has already produced a significant improvement in the physical and chemical qualities of the sugar. Most important of all, perhaps, are the beneficial effects of the sugar for bulk handling and storage—the latter being one of the very important problems facing all beet sugar technologists. Major advances in crystallization have already been made, and continuing investigations are to get as much gain as possible from each installation. The ultimate goal is to take the maximum advantage from the physical laws which control crystallization, and to produce a 100% pure crystal from a low purity mother syrup. To accomplish this would revolutionize sugar manufacture! Perhaps we shall never achieve perfection, but small advances continue to be made, and there is still good hope for further improvement in the future. It is certain that crystallization is the most powerful single weapon we have for purifying sucrose, and we must make the fullest possible use of it.

These are the quality aspects. What are the financial ones? Capital and operating costs have already been mentioned, but we can have certain financial gains from the project, to set against these costs. It is reasonable to make a comparison only on the basis of good crystal production, and for the latter, good circulation of massecuite is essential. In a vacuum pan, without a mechanical aid to circulation, this can only be achieved by evaporating water—whether this be done be adding water as such, or by using a wastefully low density liquor. Whatever means are used, it is consuming steam, not for any necessary evaporation, but only to aid circulation. By adopting a proper procedure with a stirrer, this steam can be completely saved. Again, if success is eventually achieved with automatic control, in which the stirrer plays an integral part, then as well as the main gain in consistent sugar grade, a subsidiary saving in manpower is possible.

Finally, an advantage less susceptible to costing and analysis, the visual appearance of the sparking, conglomerate free sugar coming from the granulators is a sheer delight to the eye.

Acknowledgments

Thanks are expressed to the Board for permission to continue this work and to publish it. To Mr. J. Campbell Macdonald, o.b.e., on whose instigation

the first stirrer was installed, and who throughout the years has shown the greatest enthusiasm, provided all specialized equipment where necessary for tests, and has given helpful advice, interest and encouragement throughout the investigations. To the B.S.C. mechanical and electrical engineering departments, for advice in improving the efficiency of the stirrer drive; the B.S.C. Central Laboratory, as many of the analytical results quoted are their work; and to the factory Staffs, especially at King's Lynn and Cantley, without whose enthusiasm we might not yet have reached the present achievements.

THE USE OF A GRANULAR MINERAL DECOLORIZING CARBON IN A BEET SUGAR FACTORY

by R. M. J. WITHERS and G. CRANE

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PART I

Introduction

THE purpose of the plant to be described is to take colour and other impurities out of evaporator thick juice by means of an adsorption process. The scheme of work is shown in Fig. 1.

It differs from traditional decolorizing plant by its use of a granular carbon made from a particular type of coal, and also by its continuous operation over the carbon cycle.

Traditional plants use bone char and operate batchwise so far as replenishing and re-activation of the bone char is concerned.

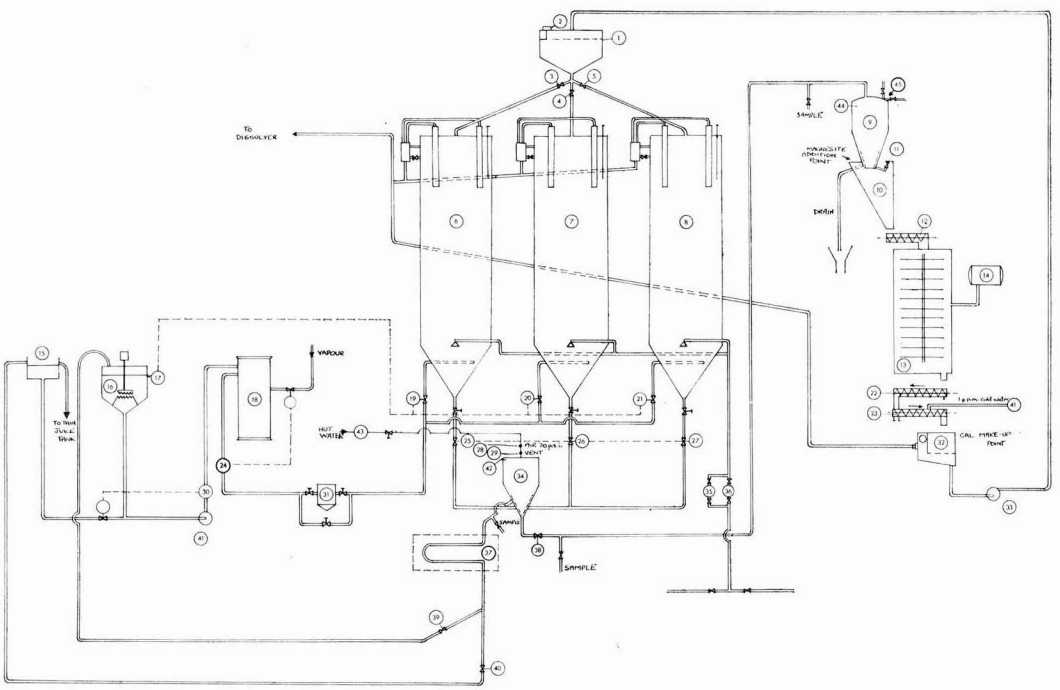

Fig. 1

Key: (1) Column feed tank; (2) Fuller level switch; (3, 4, 5) Air-operated valves; (6, 7, 8) CAL carbon column; (9) Wet bin; (10) Dry bin; (11) Power cylinder; (12) Feeder scroll; (13) Herreshoff furnace; (14) Oil tank; (15) Sweet water tank; (16) Supply tank; (17) Level transmitter; (18) Heater; (19, 20, 21) Flow control system, including valves; (22, 23) Feeder scroll and cooler; (24) Temperature control; (25, 26, 27) Air-operated valves; (28, 29) 3-way vent valves; (30) Density control system, complete; (31) "Rotoklene" strainer; (32) CAL carbon/juice feeder tank; (33) CAL carbon/juice pump; (34) Transfer chamber; (35) Pump for draining; (36) Pump to columns; (37) Rotameter density meter; (38, 39, 40) Air-operated 1-in Saunders valves; (41) Rotameter flow indicator, 0–5 g.p.m. water; (41) High-level switch; (43) Rotameter flow indicator, 0–20 g.p.m. water; (44) Mobrey high-level alarm and switch; (45) Vent valve.

A recent introduction in America has been the patented CAP or Continuous Adsorption Process. It may use either CAL carbon[1] or bone char. The patent covers the operation within the adsorption columns where the CAL is made to flow, and where the CAL is kept in an expanded condition halfway between a compact bed and a fluidized bed. In order to maintain this "expanded" bed, careful control has to be made over the flow rate of the juice, and its viscosity, and special apparatus is needed to ensure uniform velocity distribution particularly at the bottom of the columns.

In the plant at York there is no special apparatus for this purpose. The CAL is removed in batches from the column, so that most of the time the juice is flowing counter current to a stationary packed bed. First, the evaporator thick juice is received in a large buffer tank. From here it is pumped via an automatic density control system into an automatic temperature controlled heater. After this it passes through a coarse strainer, which needs occasional manual cleaning, and then into three adsorption columns.

These three columns are in parallel and the juice flow is automatically separated into three equal parts, the quantity being dependent on the level in the buffer tank. It is also possible for the melter operator to take over full control of the total flow. The juice flows up and out of the columns into the dissolver where raw and after-product crystals are melted into the juice in the usual way to give standard liquor.

The standard liquor then passes through a battery of three "Fas-Flo" totally-enclosed leaf filters. Here the juice is divided again, this time manually, reference being made to a three-pen flow recorder. Normally two "Fas-Flo" filters are working with one as a stand-by.

A certain amount of fine carbon comes over the columns into the dissolver and, although this is normally trapped on the "Fas-Flo" filters, for complete security an installation of plate and frame standard liquor presses refilters the "Fas-Flo" filtrate.

A slug of CAL carbon is introduced sequentially every four hours into the top of one of the three columns. At the same time the discharge valve at the bottom opens for a short period.

The spent carbon is discharged into a transfer chamber, the conical base section of which contains a screen. Here as much as possible of the thick juice is separated off and pumped back to the supply tank. The CAL carbon is then sweetened-off with water to about 1% sugar content.

The CAL carbon is then pumped in water into a wet storage bin where it is drained. From there it is discharged by means of a large pneumatically-operated flap valve into a dry storage bin which gives a retention time of approximately 1½ hours when recycling at the rate of 700 lb/hour. The carbon emerges at about 36% water content and travels along a screw conveyor into a star feeder to the Herreshoff furnace where it is reactivated.

The furnace has ten hearths swept by rabble arms and the CAL carbon passes through a hot zone where the impurities are driven off. The heat of combustion partly derives from the impurities themselves, and partly from the auxiliary oil-fired combustion chambers which supply the hot gases recycled round the furnace. It is fitted with automatic combustion control and recording temperature and oxygen meters.

From the furnace the carbon falls into a water-cooled screw conveyor and then to a tank where make-up is added. The make-up tank has a simple level control on a treated juice line connected to the top of the columns.

From the make-up tank the CAL carbon is pumped in treated juice to the supply tank which feeds sequentially into the three adsorption columns. When it is recycled at 300 lb an hour, a loss of 4% per cycle could mean an operating cost of £27 per day or £3400 for the campaign. It is important, therefore, that all operations including the furnace be constantly supervised to minimize loss of carbon, and that the re-cycle rate itself be brought to the minimum needed for good juice quality.

Pittsburgh CAL carbon

CAL is a granular adsorbent made from bituminous coal and has a high surface area or pore volume and is claimed to be of a structure suitable for the adsorption of colour and odour from solutions. It has a mean particle diameter of 1 mm and has 38% voids in a dense packed column. The apparent density (bulk density with dense packing) is 27·5 lb per cubic foot.

The history of this granular activated carbon was well described by A. X. HILTGEN in a paper to the American Society of Sugar Cane Technologists in 1961. In a paper to the 5th Technical Session on Bone Char in 1957, GILLETTE of Yonkers refinery deduced that a polishing operation on partially decolorized cane syrups required twenty-three times as much bone char as CAL to remove a given amount of colour.

On the other hand bone char is much cheaper to revivify than CAL mainly on account of the carbon loss. There follows a table from Gillette's paper.

Adsorbent	*CAL*	*Bone Char*
Make-up per cycle	5%	0·5%
Cost of adsorbent per lb	$ 0·30	$ 0·13
Cost of replacement/Ton	$30·00	$ 1·30
Fuel used/Ton	2 gal	10 gal
Cost of fuel/Ton	$ 0·30	$ 1·50
Total cost of revivification per ton of adsorbent	$30·30	$ 2·80

Relative cost of CAL/Bone Char = $30·30/(2·80 \times 23) \simeq \frac{1}{2}$

He concludes that CAL running costs are half those of bone char for the same duty.

The major adverse expense when comparing the two is the replacement cost of the CAL carbon. On the other hand, since so much less volume is needed the size of the plant is reduced and with it the capital cost and interest charges. Thus the financial comparison is even more favourable to CAL carbon than is indicated above.

[1] Pittsburgh Activated Carbon Company, Pittsburgh, Pa., U.S.A.

CAL carbon has found its main use in American refineries and so its use with beet juices is not well documented. Some laboratory work has been carried out in the U.K. at Liverpool and at Bramcote but no clear statement of the function of CAL carbon was available and so the York plant was mainly based on techniques established in America.

While GILLETTE and others have shown that CAL carbon does not reduce the ash in sugar, it is claimed that it reduces the floc and foaming characteristics and it was primarily for this purpose that the plant at York was built.

As will be seen in a later section of this paper, this primary purpose was, in fact, achieved.

Insofar as the effect of CAL carbon on juice colour is concerned, rather more information was available, but again there were very many more data available on cane juice than beet juice and our evidence suggests that there is a more appreciable colour reduction with the former.

It is, moreover, very difficult to compare colour figures from various sources since, apart from differences in the actual technique of colour comparison, we know that most industrial plants are liable to have small amounts of very fine CAL carbon carry-over which can go right through conventional filter media and partly affect the colour determination.

However, for any reasonable operating ratio of CAL carbon flow to juice flow we were led to expect an apparent reduction in colour of about 50% with beet juice, with contact times of the order of 3 to 4 hours.

It seems that there is a substantial benefit to be obtained in increasing the contact time from 0 to 3 hours but there is not much advantage in increasing it from 3 to 6 hours. With columns of fresh carbon and with cane juice, significantly greater reductions in colour are possible. Of course, a great deal depends on the initial colour of the juice.

We believe that the colour reduction is not very dependent on juice velocity for any given contact time.

However, so far as the British Sugar Corporation is concerned, juice colour reduction was not a primary objective since our juice colours are normally quite satisfactory for the production of high quality (A1*) sugar without carbon treatment.

The plant at York was designed and built to give a contact time of about 3 hours and did give colour reductions on the juice of about 50%.

The next problem was to decide on the carbon recycle rate since it fixes the capacity of the furnace and handling plant. At the time the only beet sugar factory using CAL carbon was Woodlands in the U.S.A. which has a CAP plant where a burn ratio of approximately 1% (i.e. 430 tons of sugar throughput with 4·5 tons of carbon recycling) is used. At that time the average rate in cane factories was about 0·7%.

We decided to size the furnace capacity for a burn ratio of 1·6% which for average York sugar throughput means a rate of 700 lb/hour. In fact we used about 300 lb/hour which gave a burn ratio of about 0·9%. This gave excellent results so far as floc-free sugar was concerned.

However, it is also necessary to consider what happens to the carbon itself and to the likely difficulties of reactivation. If the CAL is over-saturated with impurities it becomes progressively more difficult to reactivate.

The main criteria for establishing the state of the CAL carbon are apparent density, molasses number and iodine number.

The *Apparent Density* is the weight of carbon per unit volume expressed in grams per millilitre.

The *Iodine number* is the milligrams of iodine adsorbed by one gram of carbon when the iodine concentration of the residual filtrate is 0·02 normal.

The *Molasses number* is obtained in the following way:

Molasses solutions are treated with pulverized activated carbon of unknown decolorizing capacity and with a standard carbon of known Molasses Number. The optical densities of the filtrates are measured and the Molasses Number of the unknown is calculated from the ratio of the optical densities and the molasses value of the standard carbon.

The fresh carbon had an apparent density of 0·44, a molasses number of about 240 and an iodine number of about 1180. The reactivated carbon from the furnace at York averaged apparent density numbers of 0·48, molasses number of 245, iodine number of about 800. These figures represent a very reasonable reactivation.

The spent CAL carbon to the York furnace averaged an apparent density of 0·62, molasses number of about 200, iodine numbers of about 360. It is possible to run the columns on beet juice and obtain apparent densities greater than 0·66, molasses numbers less than 150 and iodine numbers less than 200 but the reactivation under these conditions is much more difficult. However, at the lower recycle rate more time could be made available for reactivation in the furnace and we have not yet obtained sufficient overall experience to say what the optimum figures for York might be.

The main reason for seeking a lower burn ratio is of course to reduce operating costs. As will be seen later replacing CAL carbon is the major operating cost and this is most directly reduced by reducing the burn ratio. However, since we believe that the major loss occurs within the furnace, any reduction in burn ratio which results in a longer retention time in the furnace need not necessarily produce significant economy.

Before leaving the CAL carbon itself some mention should be made of attrition loss.

When new, CAL carbon has a mean particle diameter of 1 mm with limits of 5% by weight greater than 12 mesh (U.S. sieve series) and smaller than 40 mesh.

A typical screen analysis of repeatedly reactivated carbon with recycle loss greater than 7% compared with new might give the following:

U.S. sieve series number	12	16	20	30	40	>40
% by weight New	0·3	20	40·9	25·1	11·0	2·4
% by weight Used	0·1	3	22	34	28	14

A more satisfactory distribution with not-so-heavily worked carbon and loss of the order of 5% might be as follows:

0·1 12 40 30 13 5.

Typical figures from within the York columns towards the end of the 1963/64 beet campaign using packed beds are as follows:

0·1 16 39 27 14 3·5

while during the 1963 refining run using free beds the analysis was:

0·2 15 53 26 5 0·8

Typical figures of the reactivated carbon from the furnace at the end of the 1963/64 beet campaign are:

0·1 14·5 44·9 30 9·6 0·9

and at the end of the 1964 refining run

0·2 13·6 53 25 6·7 1·4

Our interpretation of these data is that the CAL carbon which is not very robust and suffers attrition by mechanical handling is continually broken down at various points in the circuit but that in the furnace a significant proportion of the fines are elutriated, burned off, or lost in the cyclone or the atmosphere. In the free bed system, fines were maintained against the top screens which caused much trouble and often leaked, whereas with the packed bed system much of the fines was kept within the body of the CAL.

(To be continued)

THERMOPHILIC BACTERIAL CONTAMINATION IN SUGAR MANUFACTURE AND THE EFFECT OF ULTRAVIOLET RAYS

By R. P. MURPHY

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IT has been shown[1,2] that in the process of extracting sugar from beet and cane, the raw juices are normally very heavily contaminated with a large variety of micro-organisms. These range from the more delicate *Aerobacter aerogenes* and *Leuconostoc* to the extremely resistant *Bacillus stearothermophilus* and members of the Actinomycetales. However, it is well known that the mesophilic members of the above families are almost, if not completely, destroyed before the formation of thick juice which is almost sterile. It appears from the following work, however, that absolute sterility is never attained. Table I shows that sugar syrup taken from the vacuum pans and crystallizers is contaminated with small numbers of thermophilic organisms. These samples were taken from the vacuum pans by flaming the taps used by the sugar boilers after washing them with alcohol and allowing the mass of small crystals and syrup to flow into sterile jars. Sterile samples were removed from the crystallizers with the aid of sterile long-handled samplers which were plunged into the mass of the massecuite just inside the outflow from the crystallizers. Portions of this material, weighing 25 g, were dissolved in sterile water and made up to 100 ml under aseptic conditions.

1-ml aliquots of these solutions were pipetted into sterile Petri dishes into which 10–15 ml of sterile agar were then poured. These were then incubated for 48 hours at 30°C and 55°C and the resultant colonies were counted. Individual colonies were sub-cultured into poured plates by the streak method. The metabolic reactions of these were examined with reference to growth on individual sugars, effect on litmus milk, indole and acetylmethyl carbonal production, nitrate reduction, gelatin liquefaction and colony formation on nutrient agar. Their thermophilic characteristics were noted by examining their viability after subjecting aqueous suspensions to 100°C in boiling water for 5 minutes. The organisms were characterized according to Bergey's classification. Table II shows the types found.

Table I

Source	*Viable Count/ml at 30°C*	*Viable Count/ml at 55°C*
Thin juice	70	120
Thick juice	27	80
Vacuum Pans	119	106
Crystallizers	73	106

At no point in the time from thin juice to crystallizers is the temperature allowed to fall below 60°C and during the conversion from thin juice to thick juice a temperature of 120°C may be reached in the evaporators, the temperature falling thereafter to between 60 and 80°C. In the vacuum pans and crystallizers the temperature is usually about 70°C. At such temperatures one would expect bacterial contamination to be inhibited. This would probably be the case but for the fact that the thick juice is augmented by liquors returned from later stages in the production of the sugar. These liquors are often very heavily contaminated by heat resistant bacteria.

The bacteria are enumerated in Table II which also shows their sources.

It will be noted that the figures given in the third column of Table II do not always add up to 100%. This is due to the fact that other unidentified organisms were present. Identification in this case was merely on colony similarity and is therefore not to be taken as incontrovertible.

[1] MURPHY: "Bacteriological Contamination at Stages in Sugar Manufacture." *Paper presented to the Internal Sugar Conference, Irish Sugar Co. Ltd.*, 1963.

[2] DEVILLERS: *Proc. 9th Meeting C.I.T.S.*, 1955, 86–100.

Table II

Sources	*Type*	*% total viable count at 55°C*	*T.V.C.*
Crystalline sugar	*B. stearothermophilus*	20	104
	Actinomyces	30	
	B. cerius	5	
	B. subtilis	40	
Refinery liquors	*B. stearothermophilus*	30	2588
	B. brevis	20	
	B. cerculans	14	
	B. subtilis	36	
Vacuum pans	*B. stearothermophilus*	40	106
	B. subtilis	30	
	B. circulans	12	
Thick juice	*B. stearothermophilus*	40	70
	B. subtilis	10	
	Actinomyces	30	
Thin juice	*B. stearothermophilus*	35	640
	B. subtilis	27	
	Actinomyces	28	
	B. cerius	5	

The figures in the fourth column of Table II gave rise to the supposition that the bacterial contamination on refined sugar was not merely on the surface of the crystal because if it were one would expect to have a lower bacterial count on the refined sugar than on the mixture of crystals and syrup in the vacuum pans and in the crystallizers, particularly as the sugar is washed free of syrup with practically sterile water. To test this assumption samples of refined sugar were washed in the following solutions and dried under vacuum: (1) ether, (2) alcohol, (3) alcoholic formalin, (4) ethylene oxide[3] (gaseous % in air of 60% R.H. for 2 hours). Bacterial counts were done on the sugar before and after treatment with the results shown in Table III.

Table III

Treatment	*% total viable count/g at 55°C*	*T.V.C. at 30°C*
Untreated	14	4
Washed in ether	8	4
Washed in ethanol	4	3
Washed in 1% formaldehyde in ethanol	5	5
Washed in 3% ethylene oxide in air at 60% R.H. for 2 hr	5	4

It has been shown elsewhere that refined sugar is contaminated with mesophiles at the bagging plants and elsewhere. The sterilizing effect of the treatments shown can remove this form of contamination but have little or no effect on the thermophilic organisms present. This is interpreted as indicating that the thermophilic portion of the population is within the sugar crystals and is therefore inaccessible to the sterilizing agents used. To test the validity of this assumption and to find some means of sterilizing refined sugar it was decided to subject the sugar crystals to intense ultra-violet radiation. Both untreated and artificially contaminated sugars were used for this test.

The sugar was contaminated by adding 1 ml of water containing 22×10^6 organisms (*B. stearothermophilus*) to 100 grams of sugar and drying under vacuum. Table IV gives the results found. It will be seen that U.V. light can, under certain conditions, penetrate the sugar crystals and kill the organisms present. It will be remembered that chemical bactericidal agents were not found capable of sterilizing the sugar.

Table IV

(min)	*T.V.C. with bacteria added*	*T.V.C. on original sugar*
0	200,200	24
10	3,285	6
15	590	Nil
20	180	,,
25	50	,,
30	0	,,
40	0	,,

The sugar was subjected to the U.V. rays in Petri dishes each containing a uniform 1-cm depth of sugar.

Conclusions

(1) It has been shown that certain thermophilic organisms can survive the high temperatures and rigorous osmotic conditions found at the later stages in the production of sugar from sugar beet.

(2) It has been shown that bactericidal agents capable of killing these bacteria do not do so when the refined sugar is treated with them.

(3) It is concluded that the organisms present are shielded from the bactericidal agents owing to the fact that the organisms are inside the crystals.

(4) This assumption is shown to be correct by demonstrating that U.V. light can kill all organisms present when the sugar layer is not too thick.

(5) It has also been shown that U.V. light is effective when the sugar is contaminated with massive doses of bacteria.

(6) The fact that U.V. light kills all bacteria in a 1-cm layer of sugar uniformly contaminated is taken as proof that it actually penetrates the sugar crystals. This penetration explains why it is that U.V. light can sterilize sugar while chemical agents are unable to do so.

Summary

Certain of the most heat-resistant organisms can be found at points in the manufacture of sugar at which the conditions of heat and sugar concentration would be expected to destroy all forms of life. These organisms remain viable for considerable periods and can multiply when the sugar is dissolved and suitably diluted. It appears, from work described, that these organisms occur within the crystals, probably in the minute pockets of liquid sugar. These organisms are not therefore accessible to most bactericidal agents like formaldehyde, chlorine, alcohol, ether, ethylene oxide, etc. It is shown, however, that the sugar crystal is not impermeable to ultra-violet light and that this agent, under certain conditions, can be used to diminish the bacterial count where especially pure sugar is required.

[3] BRUCH: *Ann. Rev. Microbiol.*, 1963.

The effect of magma purity on inclusions in raw sugar crystals. D. M. STEVENSON. *Proc. 31st Conf. Queensland Soc. Sugar Cane Tech.*, 1964, 233–240.—C-sugar was boiled on high and low purity magmas in a laboratory vacuum pan to a final massecuite purity of 85 and the ash, filtrability and colour of the resultant affined sugar were determined. It was found that by increasing the magma purity from 78 to 93 the sugar ash content was reduced by 0·03%, the sugar filtrability by 15 units and the colour absorbency by 0·17–0·23.

* * *

The D.D.S. diffuser for sugar cane. H. BRÜNICHE-OLSEN. *S. African Sugar J.*, 1964, **48**, 449–459.—A description is given of the D.D.S. cane diffuser, emphasizing the differences in design and operation, as compared with the D.D.S beet diffuser, which result from the differences in mechanical behaviour and physical properties of the two raw materials. The D.D.S. cane diffuser installation at the Tanganyika Planting Co. Ltd.[1] is described.

* * *

The "Tamazula system" of graphical adjustment of cane mill turnplates. F. SERNA S. *Bol. Azuc. Mex.*, 1964, (178), 16–19.—A method is described which is used at Ingenio Tamazula for working out turnplate adjustments. A side elevation of the mill is drawn and the turnplate drawn in position according to previously fixed criteria, when the adjustments may be found.

* * *

Rapid cooling of massecuites. J. C. DE BRUYN and J. G. MEYER. *Bol. Azuc. Mex.*, 1964, (178), 19–23. The drawbacks of air-cooling of massecuites in U-shaped crystallizers are discussed and rapid cooling in water-cooled crystallizers, without dilution, is advocated (although a Werkspoor system for addition of atomized water to prevent re-solution of crystals is mentioned). The principles of rapid cooling and reheating to achieve maximum crystallization and then ease of purging are discussed and some of the literature on the subject briefly reviewed. Data are reported from an application of the system in Sweden.

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Performance of crystallizers. Comparison of air cooling and water cooling. J. C. CHOU. *Taiwan Sugar Quarterly*, 1964, **11**, (1), 16–21.—Cooling and crystal growth in air- and water-cooled crystallizers follow similar paths with 42% (air) and 46% (water) of the total temperature drop occurring in the first 10 hr, when 51·2% (air) and 68·3% (water) of the total purity drop has also occurred. After 10 hr, 58·5% (air) and 65·7% (water) of the total increment in crystal content has occurred. During this time the supersaturation falls, but thereafter it increases gradually. After 30 hr the temperature in the water-cooled unit is 8°C lower than in the air-cooled crystallizer, purity drop is 1·13 points greater and crystal content 0·88% higher. To achieve this extra crystal content, the air-cooled unit would require 43 hr cooling (*vs.* 30 hr). Thus, adoption of water-cooling increases crystallizer capacity by 40% as well as providing ease of control unaffected by atmospheric conditions.

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The D.D.S. diffuser for cane. H. BRÜNICHE-OLSEN. *Sugar y Azúcar*, 1964, **59**, (7), 36–39.—See column 1.

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Sugar factory at Edfu, United Arab Republic. ANON. *Sugar J.* (La.), 1964, **27**, (1), 26.—The new factory at Edfu, Egypt, built by Mitsubishi Heavy Industries, of Japan, completed its first crop in 1962. The plant has an initial capacity of 4000 tons of cane per day, but is designed for future expansion to 8000 tons. It uses a cane leveller, two sets of knives, a shredder and 5-mill tandem, the shredder and all mills having individual steam turbine drives. The juice is prelimed, continuously sulphited under automatic pH control, clarified and filtered using Dorr-Oliver equipment and boiled to sugar, the massecuite being cooled in Werkspoor "Rapid" units.

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Cane sugar factory makes first season with continuous cane diffusion in Egypt. M. H. TANTAWI. *Sugar J.* (La.), 1964, **27**, (1), 27–32, 44.—The Naudet process of cane maceration is described and an account given of the development of a workable cane diffusion method. The process covered by patents applied for by the Soc. des Sucreries et de Distillerie d'Egypte includes a section between a cane-grinding mill and bagasse dewatering mills. This section includes a slat conveyor which carries bagasse over a stationary screen mounted over a series of tanks. The juice draining through into these tanks is sprayed over the bagasse nearer the feed end of the conveyor, while water is sprayed on the bagasse nearest the discharge end. The juice becomes progressively more concentrated towards the feed end, where it is withdrawn from the first tank to go to process, at about 9° Bx and pH 6·0–6·1. Retention time is about 30 min. A 60 t.c.h. unit was tested at Nag-Hamadi in 1961, and a 150 t.c.h. unit operated smoothly

[1] *I.S.J.*, 1964, **66**, 187–189.

in 1962. Three 160 t.c.h. units were then installed and are to be modified to handle 200 t.c.h. each by 1969. The sucrose recovery (in bags % in cane) was 2–3% higher at Nag-Hamadi in 1962/63 than in the other Egyptian factories. Extraction averaged 96·3% compared with 94·4–95·6% for the other factories and the "filtering" effect of the bagasse blanket reduces impurities and clarifier muds. The success of the design has resulted in plans for its adoption in other Egyptian factories.

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Have you considered the horizontal continuous centrifugal separator for low grade and intermediate massecuite? P. P. STRICH. *Sugar J.* (La.), 1964, **27,** (1), 34–37.—Information is provided on the Allis-Chalmers horizontal continuous centrifugal which operates on the principle of separation of molasses from a massecuite which is applied to an acceleration cup from which it passes along the surface of a conical screen to discharge at the rim. The machine's advantages are claimed to include simplicity, compactness, high output per h.p., and ease of maintenance, and more than 20 are in operation in various U.S. sugar areas.

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Economy in the consumption of steam for the heating and evaporation of cane juice. F. GARCÍA LÓPEZ and J. A. CLARK GARCÍA. *Nuestra Ind. Rev. Tecnol.*, 1963, **1,** (5), 13–25; through *S.I.A.*, 1964, **26,** Abs. 410. The results of calculations are presented comparing the steam consumption (kg/hr), steam losses to the condenser, and total heating surface for 14 different multiple-effect evaporator systems. The latter range from a simple triple effect to a quintuple effect with vapour bleeding from the first three effects, or a quadruple effect preceded by a triple-effect vapour cell (a pre-evaporator for part of the juice, with all vapour passing to heaters). Steam pressures are assumed to be 0·63 kg/sq.cm. to evaporators and 0·63–1·41 kg/sq.cm. to vapour cells. Thermo-compressors are only briefly considered.

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Considerations on a perfection of the classical crystallization process. A. PASETTI and A. BRUNELLI. *Ind. Sacc. Ital.*, 1964, **57,** 98–101.—The process referred to was proposed by R. GRANDADAM[1] and is assessed critically. The authors express their doubts as to the economics of separating crystals from the hot massecuite before recycling the molasses for further concentration.

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Heat scheme and heat consumption in the processing of cane raw sugar. S. I. LIBOV. *Sakhar. Prom.*, 1964, **38,** 600–602.—Details are given of the heat scheme used in the 5-massecuite scheme described earlier[2]. Steam at 3 atm pressure is used in the vacuum pans, syrup tanks, minglers, remelt heaters and centrifugals, the absence of evaporators permitting the use of steam at one pressure throughout the factory. Sweet condensate from pans, heaters, etc. is used for unspecified technological purposes, while clean condensate is used as boiler feed. Total boiler feed constitutes 205% on weight of raw sugar at an average temperature of approximately 108°C; 166·5% condensate (on raw sugar) is obtained from heat surface equipment. A flow diagram is given as well as a detailed heat balance.

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New horizontal vacuum pan with plate heaters. F. DAMBRINE and J. C. GIORGI. *Sugar y Azúcar*, 1964, **59,** (8), 29–32.—See *I.S.J.*, 1964, **66,** 73, 113.

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Electric drive updates old mill. I. LOEBL. *Sugar y Azúcar*, 1964, **59,** (8), 33–35.—In order to raise milling capacity from 60 to 80–85 t.c.h. the drive was altered from a double Corliss engine installation with open gearing to a 3-electric motor drive with enclosed gearing. In addition, the 2-roll crusher was converted to a 3-roll unit. Edwards hydraulics were fitted as well as intermediate carrier clutches, and the groovings were changed. The motors fitted were Siemens A.C. 3-phase brush-shifting motors with an overall efficiency (from the turbo-set) of 87%, i.e. much higher than D.C. motors and somewhat higher than variable-frequency turbines and slip-ring motors operating under the same conditions. Maximum crushing capacity reached with the new drive was 126 t.c.h. and pol extraction has been kept at 93%.

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New $5 million mill for Ecuador. ANON. *Sugar y Azúcar*, 1964, **59,** (8), 39—Details and illustrations are provided of the new mill under construction at Tababuela, Ecuador[3].

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Process developed on deionization of sugar cane juice. ANON. *Indian Trade J.*, 1964, **227,** 167.—A process developed at the National Sugar Institute, Kanpur, is described. Clarified juice is cooled to 15–18°C and passed through a mixed bed of cation and anion exchange resins. The recovery of sugar can be increased by 8–10% and scale formation on heating surfaces is reduced, allowing continuous processing for long periods. A net profit of 25% and 28·7% on invested capital (by additional sugar recovery and sale of edible molasses) is expected for a 1000-ton and a 2000-ton factory respectively.

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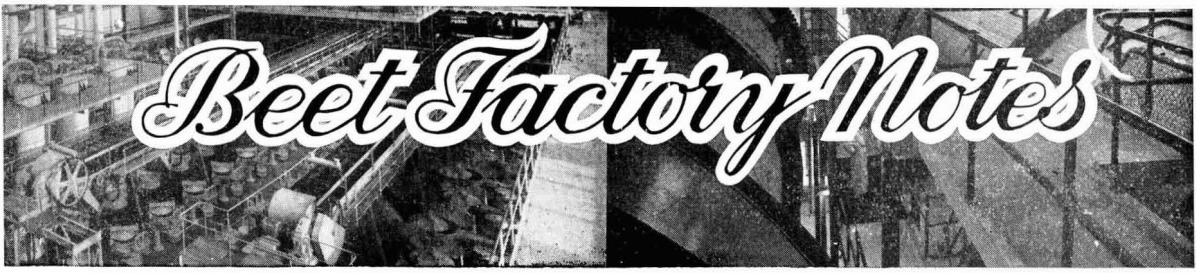
Magnesium oxide—an agent for making alkaline which reduces scale in the evaporators. ANON. *Bol. Azuc. Mex.*, 1964, (179), 17–21.—Trials were conducted at Ingenio Calipam on partial substitution of lime for clarification by MgO. Used in various proportions of MgO to CaO, the reagent was used in various quantities during a period of 16 days. The mud volume was reduced and use of MgO reduced the problem of evaporator scale. Colour and turbidity of the clear juice were improved and good quality sugar resulted. The most economical and adequate percentage of MgO will vary from factory to factory, however, and possibly from season to season.

[1] *I.S.J.*, 1964, **66,** 360.
[2] *I.S.J.*, 1964, **66,** 191.
[3] *I.S.J.*, 1963, **65,** 61.



Technological remarks and observations on the campaign at Serrae sugar factory in Greece. E. MALANOWSKI and J. DOMAGALA. *Gaz. Cukr.*, 1964, **72,** 122–124.—The results obtained in the first campaign at Serrae factory are discussed in some detail. Diffusion losses were 0·3% at an average draught of 122·8%. The average purity of 1st massecuite was 90·3 at a Brix of 92·7° (a 3-massecuite system is used).

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White sugar storage in silos. C. WEIBULL. *Cukoripar*, 1964, **17,** 161–162.—In answer to certain remarks regarding Weibull white sugar silos[1], the author of the present article produces evidence from the literature to show that the criticisms are unjustified and appends a list of Weibull silos erected in various countries during the period 1960–64.

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Modern power engineering and evaporation requirements in the sugar industry. A. ZSIGMOND. *Cukoripar*, 1964, **17,** 163–172.—A survey is presented of processes and equipment which provide high levels of steam and power production; the use of high-pressure boilers and turbo-sets is considered of paramount importance. Particular attention is paid to factors affecting steam consumption by evaporators, including heat radiation and condensate and incondensable gas withdrawal. The effect of low heat transfer coefficients and of reductions in the effective temperature drop are considered. Modern developments in this field are discussed and mention is made of a new evaporator design developed by the author which provides optimal steam consumption and low losses through sugar decomposition.

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The operation of Pavlyuk-Sokolov stone catchers. F. P. KOVTUN. *Sakhar. Prom.*, 1964, **38,** 451–452. Modifications to a rotary drum beet flume stone catcher designed by PAVLYUK & SOKOLOV[2] are described and certain other alterations recommended.

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Rational design of a carbonatation juice clarifier. I. G. CHUGUNOV. *Sakhar. Prom.*, 1964, **38,** 492–497. Reference is made to the literature on clarifier design and to some Soviet and non-Soviet clarifiers. It is concluded that the most effective design is that in which the muds are removed from each compartment in a multi-tray clarifier, the untreated juice is fed centrally and the clarified juice discharged through a single peripheral annulus. All compartments should be 750–800 mm high and each should operate as a single stage thickener. Means of isolating each compartment are suggested.

Mathematical methods in the economic work of the sugar industry. K. SOMORJAI. *Cukoripar*, 1964, **17,** 180–184.—Among the various methods described, particular mention is made of linear programming of beet supply, which takes into account manufacturing costs, process efficiency, transport costs, and sugar losses in storage. Mathematical correlation is used to show the economic effect of raising factory productivity. The manufacturing costs depend to a great extent on the length of campaign and it is shown that in Hungary costs are minimal for a 80-90 day campaign. The correlation method is also used to show the effect of capital investment used to increase throughput and shorten the campaign.

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The importance of the steam superheater in boiler operation. H. ANDERS. *Zucker*, 1964, **17,** 371–372. A guide is offered to the efficient application of steam superheating, the maintenance of superheaters and their optimum location.

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Preparing factories for processing of mechanically-harvested beet. V. A. SEREBRINSKII and M. D. SPEKTOR. *Sakhar. Prom.*, 1964, **38,** 503–508.—Measures and equipment recommended for adoption by factories receiving mechanically-harvested beet are discussed and individual items described, including trash, stone and sand catchers, and information is given on the separation of beet tails and pieces (these amount to 2–2·5% on weight of beet). They pass with the flume-wash to a water separation unit before the beet washers. The water passes to a beet tail catcher which has a 4·5 sq.m. filter screen of 35–40% open surface. This allows all the water to pass through while retaining tails and pieces, which then pass to a separate washer before being transferred to a de-pulper conveyor.

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Operation of shaft lime kilns on oil. A. I. STRIGUNOV. *Sakhar. Prom.*, 1964, **38,** 508–511.—Conversion of a lime kiln to oil burning has required installing special water-cooled beams across the kiln to allow a space free from limestone for gasification of the oil. This has led to increased efficiency and lower fuel consumption and lime costs.

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Performance of TG-80-1,6 gas blowers. V. A. CHAIKUN and V. V. SPICHAK. *Sakhar. Prom.*, 1964, **38,** 511–512.—Details are given of a proposed method of flushing out these Soviet-made gas blowers with 1st evaporator effect condensate. Replacing the

[1] FEJES: *I.S.J.*, 1964, **66,** 361.
[2] *I.S.J.*, 1962, **64,** 340.

125 kW motor with a 160 kW motor operating at 2950 r.p.m. has raised the throughput to the equivalent of 2000 tons of beet per day.

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Improving the equipment of a standard pulp dryer. YU. M. POLYAKOV. *Sakhar. Prom.*, 1964, **38**, 512–515. Information is given on modifications to the pulp dryer station at Novo-Kuban' sugar factory, which has two drum dryers heated by natural gas furnaces. Tests have shown that a uniform mix of pulp and molasses is possible when the latter is atomized by steam. The drying of such a mix is discussed elsewhere[1].

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Calculation of the quantity of products in a two-product scheme. I. P. TURANIN. *Sakhar. Prom.*, 1964, **38**, 517–518.—Formulae are presented for calculation of the various products from re-melt liquor to final molasses as a contribution to a complete sugar balance in a factory using a two-boiling scheme.

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Processing mechanically-harvested beet. K. I. MUSOLIN. *Sakhar. Prom.*, 1964, **38**, 527–530.—Experiments at Pereleshinskii sugar factory showed that mechanically-harvested beet were of poorer quality, with higher invert content and higher percentage of damaged roots. Reduced factory throughput and lower white sugar quality resulted as well as higher losses. However, the results over three campaigns have shown improvement and it is considered that at least 2–3 years must elapse before a factory can overcome the difficulties and install the necessary equipment to handle mechanically-harvested beet.

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Results of experimental reception, storage and processing of mechanically-harvested sugar beet from the 1963 harvest in the Russian Federal Republic. V. A. SELYATITSKII and S. E. FRIDMAN. *Sakhar. Prom.*, 1964, **38**, 530–536.—Tests at six factories in the R.S.F.S.R. on the storage and processing of mechanically-harvested beet are discussed, but it is stated that the short duration of the tests (processing lasted only 10–12 days) was inadequate for any conclusions to be drawn and further, longer, tests are advocated. Some recommendations are made, e.g. regarding the feeding of beet to the factory and individual processes and equipment in the factory.

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Investigation of moisture exchange processes in beet cooling. M. Z. KHELEMSKII and V. Z. ZHADAN. *Sakhar. Prom.*, 1964, **38**, 536–541.—Beet cooling and freezing tests in a wind tunnel are discussed. Certain quantitative relationships were obtained characterizing the intensity of moisture exchange between beet and cooling air. It was found the the peel of a beet reduced moisture loss and the evaporation coefficient. Test data are tabulated, and some average values of the evaporation coefficient are given for various air flow rates. The equilibrium temperature at the surface of a beet was found to be higher than the wet bulb air temperature. The surface temperature with a skinned beet was lower.

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Device for feeding formalin into a battery diffuser. G. I. DUMANETSKII. *Sakhar. Prom.*, 1964, **38**, 542. Formalin in a tank is diluted with juice from one diffuser cell and is them pumped to the next cell in the battery.

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Dependence of resistances to water and juice flow on the quality and condition of cossettes. S. ZAGRODZKI and J. KUBIAK. *Gaz. Cukr.*, 1964, **72**, 144–147. Tests are described in which cossettes were placed between two horizontal screens in a cylinder and subjected to pressure at various temperatures. The permissible increase in load fell with temperature increase as did the time taken for cossettes to lose their elasticity. Flow resistance increased to a constant value with increase in the extraction period and was greater at lower temperatures. Flow resistance also increased with load increase, with rise in the liquor sugar concentration and with length of cossette. The rise due to load increase was generally greater with cossettes from unripe and deteriorated beet than with cossettes from healthy beet.

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Counter-current ion exchange columns. A. ZSIGMOND and E. GRYLLUS. *Zucker*, 1964, **17**, 385–392.—See *I.S.J.*, 1964, **66**, 363.

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Aerobic degradation of waste waters. F. SCHNEIDER, H. P. HOFFMANN-WALBECK and D. KOLLATSCH. *Zucker*, 1964, **17**, 393–399.—While the organic impurities in waste water can be analysed by chemical degradation, i.e. oxidizing with potassium permanganate or bichromate (as in the U.S.), the values obtained are only relative, although the process is a rapid one compared with biological oxidation, which normally requires 5 days. However, a number of factors affect aerobic degradation and thus introduce errors into the analytical determination of BOD_5. These factors are discussed with reference to the literature. Various tests to find maximum degradation effects with certain agents, including a pure *Rhodotorula* culture and activated sludge, are discussed. A three-stage lagoon process (anerobic fermentation, putrefaction, and oxidation with sedimentation before and after oxidation) gave good results (about 97–98% BOD_5) with sugar factory effluent. Adjusting the pH of all the flume water and factory effluent to about 11 by liming considerably reduces bacterial activity and prevents uncontrollable degradation. Other possible means of increasing efficiency are described.

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Production of sugar, pulp and molasses in the British Sugar Corporation. J. CAMPBELL MACDONALD. *F. O. Licht's International Sugar Rpt.*, 1964, **96**, (special edition), 8–13.—A review is given of the British beet sugar industry.

[1] *Pishchev. Prom.*, 1963, (7).

Corrosion problems in the sugar industry. H. GOLDSTEIN. *Sucr. Belge*, 1964, **83**, 433–442.—Practical experience and industrial experiments on evaporator tube corrosion are reported. The juice side condition of the tube depends on cleaning, juice treatment, etc., and it would only be possible to avoid corrosion by formulating and adopting a code of good practice to prevent it. Examination of various alloyed steels indicates that a high (14–17%) chrome content is required to improve the behaviour of steel tubes; however, mild steel containing small amounts of S or P gives good results, economically and technically. Well shaped holes in the tube plate, fitting the outside diameter of the tube, are necessary to avoid thermo-mechanical deformation. The possibility of neutralizing aggressive media at the lower end of the tubes must be investigated.

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Holly Sugar Corporation Texas factory near completion. D. O'ROURKE. *Sugar J.* (La.), 1964, **27**, (1) 38, 40–41.—Details are given of the new Hereford factory under construction. This is to use the thick juice storage technique pioneered at Carlton, California[1], and will slice 6000 tons of beet per day, the sugar end capacity corresponding to two-thirds of this. The RT diffuser installed is the biggest yet in service. The first slice was planned for October 1964.

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Some aspects of sugar drying. M. PETERLIK. *Zeitsch. Zuckerind.*, 1964, **89**, 384–388.—Reference is made to the work of RODGERS & LEWIS[2] and RODGERS *et al.*[3] on the determination and form of moisture ("bound" and "free") in white sugar and on the effect of moisture on storage. Tests at Bruck an der Leitha sugar factory are discussed. Sugar was cooled to room temperature and throughly mixed and about 20 g, containing crystals of 0·75–1·0 mm, accurately weighed and dried for 3 hr at 105°C. The samples were then cooled in a desiccator over phosphorus pentoxide and the weight loss determined (this represents "free moisture"). The "bound" moisture was then determined similarly using the laboratory as a desiccator since the R.H. and temperature were maintained constant day and night. Within a short while the permissible limit of 0·04% moisture for fine and normal crystal was exceeded, confirming the relationship established between "bound moisture" and crystal size. Sugar from the centrifugal and consisting mainly of fine crystal was pre-dried in a drum dryer by hot air for about 5 min and then dried and cooled in an air stream in a so-called turbine dryer. Sugar containing mainly normal-size crystals was treated only in a turbine dryer, the upper section of which housed a heater. In the pre-drying the greater part of the "free moisture" was removed, whereas the turbine dryer retarded the process. Sugar is best dried at lower temperatures, as at higher temperatures there is danger of also removing hydration water which is rebound in storage. By increasing the spinning time by 10 sec and increasing air flow in the drum dryer, the "free moisture" was further reduced in the first stages. Five minutes' retention in the pre-dryer was sufficient under these conditions. Applying the same modifications with normal crystal sugar as with the fine crystal did not meet with success; this is attributed to the mode of operation of the turbine dryer, in which the sugar remains motionless most of the time in a 3–4 cm layer, only the top crystals being touched by the air stream. The use of conditioning plants as in the U.S. and U.K. is briefly discussed.

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Model tests on sugar dialysis from beet cossettes. W. RATHJE. *Zeitsch. Zuckerind.*, 1964, **89**, 389–390. Laboratory tests with cellophane membrances showed that water passes through the smaller pores of the membranes into aqueous solution under osmotic pressure while simultaneously the aqueous solution is filtered out through the larger pores under hydrostatic pressure. Since beet cossettes after heating to 70–80°C also have large and small pores, extraction of sugar is considered to be a result of absorption of water under osmotic pressure and expression of the sugar juice under hydrostatic pressure. Thus "dialysis" may be a better description of the sugar extraction process than is "diffusion".

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Sampler for determining the true dirt tare of beet. P. A. MASLENNIKOV and N. K. DMITRIENKO. *Sakhar. Prom.*, 1964, **38**, 543–545.—The device comprises a gantry with a hydraulically-operated hollow pipe which lowers onto the pile of a beet on a lorry, withdraws a sample and ejects it into a bag which is then labelled and sent to the tarehouse.

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Problems of sugar production in Georgia. N. V. SANTELADZE. *Sakhar. Prom.*, 1964, **38**, 566–570. Information is given on the small sugar industry (42·7 thousand tons of sugar were produced in 1963) which centres around Agarinskii sugar factory with a daily slice of 1520 tons of beet. Sugar yield is 4·1–4·7 tons/ha. The question of ending sugar production in the republic has been raised a number of times.

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Calculating the throughput of a trough-type twin-scroll diffuser. A. K. BURYMA and V. A. VAILOV. *Sakhar. Prom.*, 1964, **38**, 584–589.—Formulae presented earlier by PRIIMAK[4] are found to be based on erroneous premises. New formulae are presented for calculating the throughput of a twin-scroll DDS diffuser, and the factors affecting the "coefficient of cossette feed" and cossette retention are discussed. A worked example is given.

[1] *I.S.J.*, 1960, **62**, 312.
[2] *I.S.J.*, 1963, **65**, 12, 43, 80.
[3] *I.S.J.*, 1963, **65**, 261, 293, 324.
[4] *Sakhar. Prom.*, 1964, **38**, 25–26; *I.S.J.*, 1964, **66**, 265.

Sugar crystal growth rates in pure solutions. I. N. KAGANOV and M. S. ZHIGALOV. *Sakhar. Prom.*, 1964, **38,** 409–412.—Calculation of sucrose crystal growth rates is discussed and in particular the importance of the form in which the sucrose concentration is expressed. Three ways of expressing this are used, viz. sucrose:water weight ratio, sucrose molarity and sucrose molality. Graphs are given of crystal growth *vs.* sucrose:water ratio and *vs.* sucrose molality, respectively, at various temperatures using KUKHARENKO's experimental data. (A graph of crystal growth *vs.* molarity showed greater scattering at 30 and40°C and was discarded.) The slope of the straight lines to the abscissae (sucrose concentration) gives K, the rate constant or specific crystal growth rate. Experimental values of K are tabulated for each of the three sugar concentration expressions at 30, 40, 50, 60 and 70°C. Also tabulated are calculated values of the temperature coefficient of crystallization (= rate constant at 10°C:rate constant at temperature t°C). The energy of activation is calculated from Arrhenius' formula and a graph drawn of log K *vs.* the reciprocal of absolute temperature, showing the validity of the formula over the temperature range 30–70°C. It is shown that the crystallization process is divisible into two zones: the diffusion region, where the activation energy does not exceed 7000 cal, and the kinetic region, where the activation energy is at least 10,000 cal. The crystal growth rate (linear) is given by $2{\cdot}42 \times 10^5 \, e^{-\frac{8780}{1{\cdot}987T}} \Delta C$, where $2{\cdot}42 \times 10^5$ represents the value of the Arrhenius constant A, 8780 is the activation energy (cal), 1·987 is the gas constant R (cal), and ΔC is the surplus sucrose concentration expressed as molality. Where the sucrose: water ratio is used, the value of A is $9{\cdot}73 \times 10^5$.

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Relationship between heat and mass transfer in crystallizing disperse systems. I. G. BAZHAL. *Sakhar. Prom.*, 1964, **38,** 412–414.—From a straight-line graph of the amount of water evaporated *vs.* the amount of sugar crystallized in the corresponding period (prepared using data from the literature), an expression was obtained relating the water and sugar contents in syrup feeds and based on the tangent of the slope of the curve to the horizontal axis (water evaporated).

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The chemical composition of beet from the Krasnodar region. I. F. ZELIKMAN and N. L. TROYANOVA. *Sakhar. Prom.*, 1964, **38,** 415–419.—Lower raw juice purities and higher molasses yields from Kuban' beet than from beet in other Soviet regions led to detailed analysis of the beet. The results agree closely with values found by other authors previously and show a high content of noxious nitrogen (0·084–0·182% by weight). While there was a tendency for the noxious N content to increase with sugar, no relationship could be established between the two factors. Various methods for evaluating beet were tested, including those based on the MW factor[1], calculation of 2nd carbonatation juice purity[2], and calculation of molasses sugar content[3]. None of the methods studied agreed with results obtained by the authors of the present article using indirect means, a fact attributed to their failure to take into account the noxious N content with its effect on the composition of products, molasses purity and yield.

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Complexometric determination of calcium salts in molasses after preliminary decolorization of the latter with active carbon. I. F. BUGAENKO and M. A. TIMIMI. *Sakhar. Prom.*, 1964, **38,** 436–437.—Molasses solution is treated with 20% HCl solution, heated, diluted, cooled and decolorized by adding active carbon. After 10 min it is filtered and the residue washed with water. The filtrate and washings are made alkaline with 20% NaOH solution, and ammonia buffer solution added. The solution is titrated with N/28 EDTA solution. The results are slightly higher than values given by the oxalate method; the difference is attributed to the presence of Mg salts, not determined by the oxalate method.

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Influence of glucose and fructose on the difference between apparent and gravity purities of juice and molasses. E. C. VIGNES and M. RANDABEL. *Ann. Rpt. Mauritius Sugar Ind. Res. Inst.*, 1963, 138–140. Abnormally high differences between apparent and gravity purities were found to be linked with the nature and relative amounts of reducing sugars present.

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The use of basic lead acetate for juice preservation. J. DUPONT DE R. DE ST. ANTOINE and M. M. ABEL. *Ann. Rpt. Mauritius Sugar Ind. Res. Inst.*, 1963, 140–141.—It was found that if composite juice samples stored in a refrigerator overnight were preserved with 20 g of Horne's lead subacetate per litre, their sucrose content (as measured by the Jackson & Gillis No. 4 method) was 0·1 units lower (14·09 *vs.* 14·20% and 13·33 *vs.* 13·42%) than when 10 g/litre was used. The lower amount is therefore recommended.

[1] SOMMER: *I.S.J.*, 1959, **61,** 118.
[2] CARRUTHERS *et al.*: *I.S.J.*, 1962, **64,** 344.
[3] VUKOV & BÁRÁNY: *I.S.J.*, 1964, **66,** 128.

Osmophilic yeasts in sugar products. R. ANTOINE, R. DE FROBERVILLE and C. RICAUD. *Ann. Rpt. Mauritius Sugar Ind. Res. Inst.*, 1963, 134–138. Micro-organism counts were made on massecuites from a crystallizer steamed before filling, an un-washed crystallizer serving as control. Yeasts were fewer but there were more bacteria. Spraying the steamed crystallizer with an iodine-containing detergent, "Iosan", did not give any improvement on steaming. Samples taken during discharge show increasing counts. Yeast counts on raw sugar at two factories and during storage at the docks showed that yeasts decreased considerably or disappeared during 3 months' storage. Examination of samples from August to November showed highest yeast counts later in the season.

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The direct determination of fibre in cane. J. DUPONT DE R. DE ST. ANTOINE and R. DE FROBERVILLE. *Ann. Rpt. Mauritius Sugar Ind. Res. Inst.*, 1963, 142–146. Use of a Jeffco Model 265 cutter-grinder for cane analysis was compared with the "Cutex" method described earlier[1]. The Jeffco machine is a vertical hammer mill having a central spindle carrying two heavy cutters which revolve at 3000 r.p.m. at a clearance of 0·15–0·020 inches from fixed anvil bars. A plate with $\frac{1}{4}$-in perforations is located below the hammers; smaller holes caused a rise of temperature in the cane with resultant evaporation. The treated samples were lixiviated hot and cold; Rietz disintegrators were used in tests where they were available. Use of the Rietz machine is preferred to cold lixiviation, giving quicker and more reproducible results. The Jeffco cutter-grinder disintegrated the cane much more fully than the "Cutex", so increasing the accuracy of fibre determination. It is preferable to carry out the analysis on cane as fed to the mills rather than samples from the cane carrier, although accurate and representative sampling of knifed cane may be difficult.

* * *

Laboratory determination of the air content of foaming molasses. K. WAGNEROWSKI, D. DABROWSKA and C. DABROWSKI. *Gaz. Cukr.*, 1964, **72**, 116–119.—The foaming of low-grade massecuite in crystallizers is discussed[2] and two methods of determining the air content of foaming molasses are described. The first method, in which the s.g. of deaerated and foaming samples is determined pycnometrically at 20°C and normal pressure (760 mm Hg), suffers from two disadvantages: it is time-consuming and analytical errors may arise. The second method is rapid and consists in measuring the compressibility of a foaming sample. A simple piston device is used; the difference between the positions of the piston in the vertical cylinder before and after loading is a measure of the volume of gas in the molasses. The foam content is again expressed as c.c./100 g molasses at 20°C and 760 mm Hg. Formulae for both methods are given as well as worked examples.

Governing factors influencing the filtrability of Taiwan raw sugar. I. The relation between filtrability and changes in the amounts of impurities of raw sugar solution before and after the filtration test. C. S. CHANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1964, (34), 147–155.—An inverse relationship has been found between turbidity of raw sugar solutions and their filtrability. The relationship between individual impurities (starch, silica, gum, wax, etc.) and its retarding effect on filtrability is indistinct. Investigation of changes in the concentration of such impurities indicated that some of them entered the cake, obstructing passage of the sugar solution, the effects for different impurities combining. It is suggested that the retarding effect of the impurities may be dependent not on their total concentration, but on the amount dispersed in suitable particle sizes.

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Tables for the Bonvecha instrument (hygrometer), A. F. KUTYR'. *Sakhar. Prom.*, 1964, **38**, 515–516. While the hygrometer (based on the water-calcium carbide reaction) is considered highly suitable for rapid routine work, no provision is made for a special burette. Consequently, a scale of moisture content must be calculated, or, if a 100-ml burette is used, a table of values applied showing the corresponding moisture content % per ml of acetylene.

* * *

Melassigenic coefficients of non-sugars in standard molasses as a function of their effect on molasses viscosity and sucrose solubility. T. P. KHVALKOVSKII. *Sakhar. Prom.*, 1964, **38**, 580–583.—Crystal sugar was added to molasses solutions to which specific non-sugar solutions had already been added and crystallization carried out for four days at constant temperature. After centrifuging, the run-offs were analysed for Brix, purity and viscosity. A graph of Brix *vs.* log viscosity was drawn from the results and used to establish the standard Brix and purity of the run-offs. The effects of the anions and cations on the melassigenic coefficient were determined and values tabulated. The melassigenic effects of the cations in descending order were: $Na^+ > K^+ > Ca^{++} > Mg^{++}$; since the first two gave almost identical values of melassigenic coefficient (g sucrose per g.-ion), the amount of sugar bound per g.-equiv. of K^+ was far greater than that bound per g.-equiv. of Na^+. The melassigenic effects of the anions in descending order were: carbonate > acetate > chloride > glutamate > betaine > lactate > nitrate. The Ca and Mg salts were far less melassigenic than K and Na salts, while Mg and Ca nitrates had a negative effect. Not only do such non-sugars not bind the sugar, but they inhibit the melassigenic action of other non-sugars in their presence. Cations combined with different anions have different effects on molasses formation.

[1] *Proc. 10th Congr. I.S.S.C.T.*, 1959, 163–167; *I.S.J.*, 1961, **63**, 114.

[2] *See also I.S.J.*, 1964, **66**, 196.

The mechanism of the bacterial-enzymatic rearrangement sucrose → isomaltulose (6-[α-D-glucosyl]-D-fructose). W. MAUCH and S. SCHMIDT-BERG-LORENZ. *Zeitsch. Zuckerind.*, 1964, **89**, 309–315, 375–383.—The problems of bacterial-enzymatic synthesis of isomaltulose are discussed and a proposed modification to the enzyme system is described which affects the saccharides. A survey of the literature on enzymatic synthesis of saccharides is given. The reaction mechanisms possible in the synthesis of isomaltulose are discussed and tests reported in which labelled D-fructose or D-glucose were used. The results showed that a certain proportion of D-fructose is absorbed into the synthesized isomaltulose, so that the reaction is one of the transglucosylation and the catalytic enzyme is a sucrose → isomaltulosetransglucosylase. This same enzyme causes transference of the D-glucosyl residuum in the sucrose to other monosaccharides. Isomaltose, 6-[α-D-glucosyl]-D-mannose or α-D-glucosyl-D-arabinose is formed as well as isomaltulose in mixtures of sucrose + D-glucose, sucrose + D-mannose or sucrose + D-arabinose.

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Conductimetric determination of the total carbonate ash, alkaline ash and calcium salts contents (in molasses). I. F. BUGAENKO and M. A. TIMIMI. *Sakhar. Prom.*,1 964, **38**, 603–607.—Alkaline ash in molasses solutions was determined as the sum of the total carbonate ash and lime salts. The carbonate ash was determined conductimetrically; the difference between this value and the value given by multiplying sulphate ash by 0·9 did not exceed 0·2%. The lime salts were determined by conductimetric titration with N/28 "Complexon III" (EDTA) after buffering to pH 8·2 with a borax-boric acid-NaCl buffer. Comparison with volumetric titration showed good agreement. The difference between the total alkali ash found by the new method and from the sulphate ash did not exceed 0·2%, while the method is simpler and more rapid.

* * *

Chemical mechanism of white sugar dampening. I. Adsorption of water vapour on sucrose crystals. K. Číž. *Listy Cukr.*, 1964, **80**, 171–174.—Sugar dried to constant weight was then subjected to moisture absorption tests. The greatest increase in moisture content occurred with poor quality sugar and with smallest grain. Refined sugar with low ash and reducing sugars contents showed least dampening. Moisture absorption on sugar crystals rose to a maximum after a certain time and then remained approximately constant. The amount of moisture absorbed depended on atmospheric water vapour pressure; a relationship is expressed with good approximation by an empirical equation. This equation includes a constant which varies according to those factors most important in storage (ash content, reducing sugars content, interfacial active substances and grain size). This constant is suitable as a numerical guide to refined sugar "storability" and recommended ranges of R.H. are given corresponding to ranges of its values.

* * *

Quality determination of white consumption sugars. F. SCHNEIDER, A. EMMERICH and C. REICHEL. *Zucker*, 1964, **17**, 416–420.—Details are given of the Braunschweig "points system" of white sugar evaluation which comprises four parts: determination of colour type, of colour and turbidity in solution, of coloration on heating, and of conductimetric ash. The total number of points will be lower the higher is the sugar quality. The effect on sugar evaluation of omitting the test for coloration on heating and the extent to which this could be compensated by altering the number of points for ash content are discussed. Only a very slight difference was found between the points for ash and for coloration on heating, and comparison of the total points with the coloration test and without this test but with doubling of the ash points showed that the average total number of points was not essentially changed—the total for a good quality sugar is lower and that of a poorer sugar higher than with the coloration test. The coloration test on its own takes 1 hr, while the other 3 tests require only ½ hr.

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Comparative studies of infection in beet press juices. S. SCHMIDT-BERG-LORENZ, W. MAUCH and J. KONARKOWSKI. *Zeitsch. Zuckerind.*, 1964, **89**, 456–459. Incubation tests with press juice showed that while there is a relationship between increase in the bacterial population at 30°C and acid formation in the juice (as indicated by fall in pH), there is no relationship between acid formation and the number of thermophilic bacteria at 65°C. This finding is in agreement with observations on factory juices. The discrepancy is explained by the fact that so-called "mesothermophiles" (active at 30–55°C) form acids beyond their optimum growth range since their enzymes remain active longer than the living organism. Since it is evident that these mesothermophiles contribute more to a possible fall in pH than do the true thermophiles, it is recommended that the total germ or cell count be determined in the juice.

* * *

Definition of the principal concepts in sugar colorimetry. V. VALTER. *Listy Cukr.*, 1964, **80**, 249–254. The basic concepts in light physics are discussed with reference to sugar colorimetry. The importance of the internal light penetration factor for a precise definition of the laws of colorimetry is underlined and an indication given of conditions under which this factor can be replaced by the light penetration factor. The need for a standard system of colorimetry nomenclature and symbols is emphasized.

Studies on crystallization. G. PIDOUX. *Zucker*, 1964, **17**, 487–490.—Experimental work on sugar crystallization carried out by the author in collaboration with N. TIKHOMIROFF since 1961 is discussed. A supersaturated sugar solution was studied by chromatography, measurement of optical density and refractive index, interferometry, calorimetry, dilatometry, and measurement of specific heat and viscosity. The results of these individual studies have been interpreted together. Variation in viscosity of a supersaturated solution is explained as follows: a supersaturated sucrose solution is a colloidal suspension of hydrated sucrose associates surrounded by a solvent. Should the solvent be deficient, the structure is deformed and individual molecules tend to form agglomerates with the associates. The associate in which a "foreign" molecule "embeds" itself reacts by altering its structure and may release one or several water molecules. Thus it attempts to regain equilibrium, as indicated by alterations in the diameter of the sucrose spot on chromatography paper. The molecular reciprocal effect of the associates is increased and they have a greater attractive power for the excess molecules. With further structure changes, the deformed associates separate from the other associates and form crystals. Such an associate is termed a "protonucleus". The diameters of the associates increase with formation of the protonuclei and this causes other phenomena including a rise in viscosity. Thus three phases occur: pre-crystallization (growth of the solvated protonuclei), the formation of desolvated nuclei and crystallization proper.

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Use of membrane filters for determining microbial counts in sugar products. A. B. RIZZUTO and G. R. JACOBSON. *Amer. Soft Drink J.*, 1964, **118**, (815), 30–34, 36, 38; through *S.I.A.*, 1964, **26**, Abs. 604. Comparative determinations by means of 0·45μ membrane filters, 0·80μ membrane filters, or the standard pour plate method were carried out on pure cultures of *Saccharomyces cerevisiae*, *Penicillium notatum* and *Bacillus subtilis*, and on commercial granulated sugars and liquid sugars (samples of 5 g dry sugar equivalent). The sugar samples were distributed over 4 plates or 1 membrane filter and incubated for 72 hr or 48 hr respectively at 28°C in an inverted position. Similar counts were obtained for yeasts and moulds by each method. The counts obtained on wort agar and low pH mycophil agar did not differ significantly. In the case of bacteria, similar counts were obtained on plates and on 0·45 μ membrane filters. It is concluded that the membrane filter method is reliable in these determinations and its advantages in precision, work saving and (in the case of yeasts and moulds) time are briefly considered. Average counts per 10 g D.S.E. for 250 samples of "Bottlers" grade sugars were granulated sugar, 0·3 yeasts, 0·6 moulds, 38 mesophilic bacteria; liquid sugar, 6 yeasts, 0·1 moulds, 34 mesophilic bacteria.

Use of deep freezing for preserving beet brei samples for evaluating sugar beet tests using a mobile preparation laboratory. H. LÜDECKE and M. NITZSCHE. *Zucker*, 1964, **17**, 505–514.—Beet brei samples from different regions and localities in West Germany are frozen in a special deep freezer at —30°C in a special mobile laboratory operated by the Göttingen Sugar Beet Research Institute. When 3000 samples have been collected, the laboratory returns to the Institute, where the samples are kept at —20°C before testing. They are then thawed for 24 hr at +5°C, mixed and polarized after lead subacetate clarification. Noxious N and soluble ash are also determined. It was found that decomposition of the brei occurred only after 6 hr at room temperature, but that longer storage was possible at —30°C without any change in the quality-determining factors. There was no difference in the values of the various factors when the brei samples were thawed quickly in a drying oven at +50°C or at room temperature or thawed slowly at +5°C in a refrigerator, even when the samples were re-frozen for further storage immediately after testing. With cold digestion, mechanical shaking was not required because of the excellent mixing.

* * *

Crystallization of sucrose from solutions in the presence of raffinose. O. V. BRAUN. *Izv. Vysshikh Ucheb. Zaved., Pishch. Tekhnol.*, 1964, (1), 107–108; through *S.I.A.*, 1964, **26**, Abs. 618.—Sugar solutions containing 0·05–1·50% of raffinose were prepared from white sugar and raffinose. After nucleation at >1·10 supersaturation, the latter was adjusted to 1·05–1·07 and crystallization was allowed to proceed for 85 days. The mean crystal weight decreased with raffinose concentration from 0·187 g to 0·137 g at 0·50% and 1·50% respectively. The interior half of the crystal was shown by paper chromatography to be free of raffinose. Raffinose therefore impedes the crystallization of sucrose (perhaps by surface adsorption) without becoming incorporated into the crystal.

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The effect of borax on the polarization of mixed juice and final molasses. L. CLENDINNING, W. G. PATERSON, E. H. PHIPSON and W. S. GRAHAM. *S. African Sugar J.*, 1964, **48**, 649–659.—Analyses were carried out on mixed juice over 3 months at Tongaat and Empangeni and at the S.M.R.I. on molasses samples from Natal and Swaziland factories and the Hulett refinery. Sucrose was determined as was pol in the presence and absence of borax as recommended by LÓPEZ [1]. The pol values of mixed juice were very slightly different and both were lower than sucrose. With the molasses samples, the sucrose lay between the two pol values, which is attributed to the annulment of rotation of invert sugars but remaining effectiveness of dextro-rotatory substances (perhaps gums) not affected by the borax. It is not thought that appreciable benefits would be achieved by adopting the method, which is not recommended for Natal.

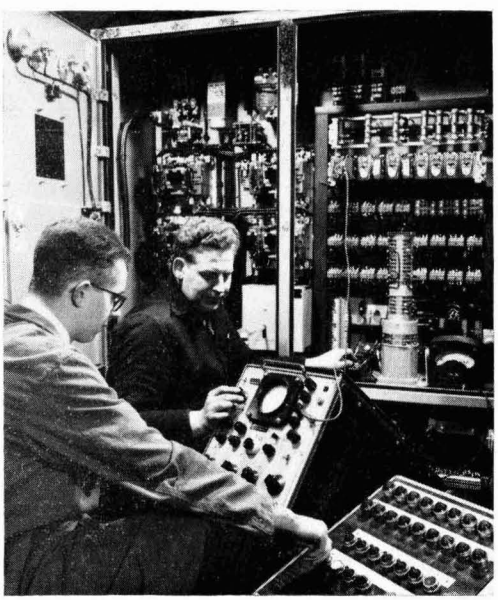
[1] *I.S.J.*, 1963, **65**, 46–48, 72–73, 107–109.

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.

New automatic drive for sugar centrifugals. Thomas Broadbent & Sons Ltd., Central Ironworks, Huddersfield, Yorkshire.

Thomas Broadbent & Sons Ltd., who have been making centrifugals for the sugar industry for over 60 years, have recently introduced a major advance in the electro-mechanical specification of their machines. In addition to the three speeds of their standard synchronous induction motors, two adjustable speeds are now provided—for feeding, in the range 100 to 350 r.p.m., and for ploughing, in the range 30 to 70 r.p.m. The pre-selected speed remains both accurate and stable, but may be readily varied at any time. This advance stems directly from Broadbent's policy of integrating electrical and mechanical design work, which has resulted in the design and manufacture of centrifuges suitable for other industries as well as for sugar.



Testing the control panel used to programme the new automatic Broadbent 5-speed sugar centrifugal.

The new concept of a five-speed motor has been made possible by the introduction of a simple closed loop servo system of control. This compares the output voltage of a tacho-generator fitted to the centrifugal shaft with a reference voltage. The difference in voltage is amplified and fed to reactors controlling the main power supply to the motor. Adjustment of the reference voltage selects either ploughing or feeding speed. The relays, which are actuated by the tacho-generator as it reaches its pre-selected speed, switch the main motor from one winding to another irrespective of basket load. This eliminates all unnecessary "dead" time in the centrifugal cycle. The controlled circuit has added advantages that it contains no moving parts, and that, in the event of failure of any component, all equipment on the centrifugal would fail to safety. Thus if anything went wrong during ploughing, for instance, the plough would immediately retract from the basket.

The use of this servo system of control allows Broadbent centrifugals to retain their "wobbly" motor design which eliminates the necessity for any form of flexible coupling between the drive motor and the basket. Another recent innovation is a solenoid operated rotary switch. This switch replaces most of the circuit relays and ensures that each sequence must be complete before the next can begin. The introduction of these important improvements coincides with the Centenary celebrations of the Company which was started by Thomas Broadbent 100 years ago.

* * *

New cane carrier with outboard rollers. Link-Belt Co., Prudential Plaza, Chicago, Ill., 60601 U.S.A.

Link-Belt Company has introduced a new cane carrier with outboard rollers, designed to meet the high tonnage requirements and rugged operating conditions of today's sugar mills. This apron-like conveyor is built to withstand the deflections imposed by loading and the pressures exerted by the cane knives. Only two strands of chain are required, because the chains are larger than conventional carrier chains. Because of the outboard roller design, the chains are not subjected to vertical loads. Horsepower requirements are lower than for standard carriers, because the larger rollers (5 or 6-in dia.) reduce friction factors. This also permits conveyors with longer centres; where two conveyors formerly needed to be "piggy-backed" to deliver cane to the mill, one conveyor will now do the job.

The two strands of offset-sidebar bushed roller chain are located beneath the ends of the pans, where they are protected from material spillage. The single-flange rollers are of grey iron with the outer edges hardened. Hexagonal tie rods act as the cane carrier axles and transfer the load to the rollers. Apron pans are available up to 10 ft wide, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$ or $\frac{1}{2}$ in thick, with sides 4 or 6 in high. Offset side plates are welded to the ends of the pan to prevent leakage.

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Magnetically coupled flow meter. Rotameter Manufacturing Co. Ltd., 330 Purley Way, Croydon, Surrey.

This new model in the Series 500 range of magnetically coupled flow indicators is of simpler construction and provides direct indication to an accuracy

better than $\pm 2\%$ of the flow being measured. These meters are mainly intended for the flow measurement and indication of liquids at high pressures and temperatures or for liquids which are too opaque for measurement with the glass tube type of "Rotameter". The Series 500 range falls into three main groups: those covering flows up to 2500 g.p.h.; larger meters for flows up to 90,000 g.p.h.; and meters for use with opaque liquids which, for chemical reasons, require the use of glass as a contact material. These can accommodate flows up to 2100 g.p.h.

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Belt conveyor kit. Electro ma (Industrial Equipment) Ltd., 205 Chingford Mount Road, Chingford, London, E.4.

Following the successful application of the flat belt conveyor kit in a wide variety of industries, Electroma have now introduced a troughed belt kit for conveying powdered and granular materials. The belt is supported by flexible idlers, and can be horizontal or inclined. The new design fitted with a metal detector affords a convenient method for the detection of tramp metal and also for transferring material from a hopper to the next process in a production line.

Initially one purchases for current requirements and the special sectionalized construction makes provision for future needs in both length and width. Its extremely clean line with enclosed drive makes it ideally suited to the modern factory.

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PUBLICATIONS RECEIVED

BMA INFORMATIONEN. Braunschweigische Maschinenbauanstalt, 33 Braunschweig, Postfach 295, Germany.

The latest issue of this magazine, No. 3, is available in German and includes a number of articles of interest to sugar technologists; these include one on BMA diffusion towers and others on the first 10 years of the Chilean sugar industry, milling plant for Central America, erection of a beet sugar factory at Tadla in Morocco, introduction into service of the new P 1000 fully automatic batch centrifugal, etc.

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YOU CAN MAKE SUGAR BETTER WITH NASH LIQUID RING PUMPS. Nash International Company, Norwalk, Conn., 06856 U.S.A.

This claim is made in a new booklet, Bulletin 426-A, which describes the operation and various uses in the sugar factory of Nash pumps on filter, vacuum pan, instrument air and carbon dioxide applications. Also included are illustrations and schematic drawings of typical installations.

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THE "AIRMIX" WET DUST COLLECTOR. Thermix Industries Ltd., 143 Maple Road, Surbiton, Surrey.

A new 8-page leaflet describes the "Airmix" wet collector which is a self-induced spray-type vertical venturi unit featuring a dense bed of liquid in a finely-divided state created by internal re-circulation in the vertical diffuser section. It uses no filters, pumps, nozzles or small orifices and is entirely self-recirculating in action. It is manufactured in a range of standard sizes with capacities from 1300 to 33,000 c.f.m.

VERSIL HANDBOOK OF THERMAL INSULATION. Versil Ltd., Rayner Mills, Liversedge, Yorkshire.

This useful and attractive booklet gives tables of figures on thermal data and surface losses, etc., in addition to a great deal of information on the "Versil" glass fibre materials for insulation, their properties and applications, etc.

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RESEARCH CHEMICAL CATALOGUE AND PRICE LIST. T. J. Sas & Son Ltd., Victoria House, Vernon Place, London W.C.1.

Companies or individuals interested in rare chemicals for research are invited to write for a copy of this catalogue of chemicals which are difficult to find and are often not available from suppliers of general laboratory chemicals.

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HOW TO GROW BETTER SUGAR CANE. Agricultural Division, African Explosives & Chemical Industries (Rhodesia) Ltd., P.O. Box 989, Salisbury, Rhodesia.

This small book, being distributed to all Rhodesian cane planters (who number over 50 averaging 150–300 acres each) as well as to the four large Company estates (6000–30,000 acres), is more an instruction manual than a sales promotion venture, since it gives much useful information on the cane plant and cultivation techniques, water management, etc. which will be found of use not only in Rhodesia but in other parts of the sugar cane growing world.

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International consultancy from Hawaii.

American Factors Associates Ltd., formed in 1959 to provide international sugar consulting services and agricultural property management and development, has been reorganized and expanded early this year to meet a large increase in business. A number of prominent, internationally-known, sugar technologists serve on the staff of A.F.A. and are available to clients for consulting work. They include Dr. L. D. BAVER, Director Emeritus of the Hawaiian Sugar Planters' Association Experiment Station; Dr. A. J. MANGELSDORF, retired principal geneticist, H.S.P.A. Experiment Station; R. G. WATT, senior factory consulting engineer; J. P. MARTIN, retired principal pathologist, H.S.P.A. Station, and others. American Factors Associates is a wholly-owned subsidiary of American Factors Ltd., the largest sugar producer in Hawaii with six affiliated plantations, and sugar holdings in South America, and large agricultural operations in Australia. Services range from land development, irrigation and selection of cane varieties, to design and construction of sugar mills. Field mechanization and automation of sugar factories are other areas in which the company specializes. The Company will also assign personnel from their affiliated plantations to carry out projects anywhere in the world. In addition, they offer training for personnel from international sugar areas on their Hawaiian plantations.

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Sugar silos at Spalding.—John Laing Construction Limited is to start work shortly on a contract for the erection of two 12,000-ton capacity silos and an elevator tower, at Spalding, Lincolnshire, for the British Sugar Corporation. The project is due for completion next October. The silos will be 175 ft high with an internal diameter of 66 ft. The pre-stressed, post-tensioned concrete walls will be nine inches thick. Each silo will have a four-foot thick reinforced concrete sugar floor 10 ft above its base. The elevator tower will be rectangular in shape, measuring 20 ft by 14 ft 3 in internally, and rising to a height of 200 ft. The walls, for which lightweight aggregate will be used, will be 11 in thick. The buildings will stand on a 4 ft 3 in-thick reinforced concrete raft foundation supported by 344 40-ft deep piles. An elevated structural steel conveyor bridge will be constructed from the elevator tower across the two silos. The contract will also include a weigh building and an air-conditioning building, to be situated on either side of the elevator tower. The weigh building will be of concrete construction and the air-conditioning building will be of brickwork construction with concrete roof and flooring.

U.K. SUGAR IMPORTS AND EXPORTS[1]

IMPORTS

Refined sugar (*tons*)	1964	1963	1962
Belgium	40	2,556	142
British Guiana	2,145	1,918	—
Canada	1,602	3,406	2,482
Cuba	497	14,122	4,252
Czechoslovakia	8,647	32,807	37,802
Denmark	12,002	6,741	—
France	3,098	8,640	2,917
Germany, East	3,525	21,402	5,474
Germany, West	2,269	3,603	1,372
Hungary	—	—	2,027
Ireland	16,238	16,529	12,238
Netherlands	900	2,352	99
Poland	571	4,610	20,043
Trinidad	1,959	1,938	150
Uganda	498	999	—
U.S.S.R.	—	17,452	13,143
Other countries	1,021	2,221	78
	56,013	141,296	102,219
Raw sugar (*tons*)			
Australia	460,190	415,248	436,342
British Guiana	96,382	136,882	144,702
B.W.I.	545,065	641,294	516,072
Canada	—	245	248
Fiji	143,782	144,791	96,246
India	10,270	29,468	3
Mauritius	423,466	444,392	401,310
Rhodesia & Nyasaland	20,638	14,921	—
South Africa	134,372	186,556	185,354
Argentina	15,601	—	—
Belgium	5,911	—	—
Brazil	20,493	15,063	—
Cuba	90,151	180,323	127,556*
Czechoslovakia	—	4,312	—
Dominican Republic	52,411	19,776	7,992
France	3,494	—	5,206
Germany, East	—	1,058	—
Germany, West	727	33,188†	1,961
Guatemala	9,429	1,545	—
Indonesia	40,211	10,081	—
Mexico	20,295	—	5
Netherlands	—	2,020	—
Peru	57,572	18,603	—
Poland	37,602	34,864	109,798
U.S.S.R.	—	26,941	—
Other countries	25,978‡	2,297	9,369§
	2,214,040	2,363,868	2,042,164

* Including 10,197 tons originating in Cuba but shipped from Portugal.

† Including sugar originating in Cuba and the Dominican Republic and entering the U.K. for in-transit refining.

‡ Including 5430 tons from Ecuador, 10,354 tons from Taiwan and 10,192 tons from Turkey.

§ Including 9366 tons from Rumania.

EXPORTS

Refined sugar (*tons*)			
Aden	1,828	109	657
Bahrein, Kuwait, etc.	14,227	425	1,243
Bermuda	506	403	763
B.W.I./Bahamas	1,418	944	2,516
Canada	59	15	1,299
Ceylon	1,223	971	810
Cyprus	7,434	4,541	9,659
Gambia	220	376	589
Ghana	8,179	5,302	21,048
Gibraltar	830	1,098	1,070
Kenya	263	7,890	21,823
Malaysia	18,183	17,965	19,643
Malta/Gozo	1,330	1,301	1,388
Nigeria	23,518	20,885	31,668
Rhodesia/Nyasaland	10	23	365
Sierra Leone	9,393	7,205	12,249
Tanganyika	—	6,001	3,549
Other British Commonwealth	660	1,097	4,151
Total Commonwealth	89,281	76,551	134,490
Belgium	28	26	26
Bolivia	—	—	8,784
Burma	228	70	35
Chile	1,457	1,526	452
Denmark	7	11	9
Egypt	103	17	18
France	93	384	444
French Pacific Possessns.	2	703	1,460
Germany, West	1,240	61,323	19,936
Greece	32,218	6,617	20
Iceland	465	413	202
Iran	9,475	98	116
Iraq	4,946	9,841	1,304
Ireland	2,695	452	114
Israel	182	77	267
Italy	10,269	13,392	12
Lebanon	2,509	4,865	1,550
Libya	420	2,033	403
Muscat and Oman	576	22	20
Morocco	—	30	3
Netherlands	139,151	36,410	22,453
Norway	31,147	69,288	57,186
Saudi Arabia	44,367	20,764	414
Spain	6,812	11,050	45
Sudan	—	19,758	—
Sweden	18,341	8,830	262
Switzerland	34,819	52,499	36,212
Tunisia	2,952	3,138	19,676
Turkey	1	1	1
U.S.A.	189	4	3,054
Other countries	3,159	1,769	3,692
Total Foreign	347,851	325,411	178,170
Grand Total	437,132	401,962	312,660

BREVITIES

Antigua drought.—The Chairman of the Antigua Sugar Factory Ltd., W. A. Du Buisson, announced recently that, owing to abnormal drought conditions in Antigua, the prospects for 1965 were far from promising. Less than 9 inches of rain fell during September to November 1964—when the heaviest rain is expected—compared with an average of about 18 inches in a normal year. Growth of the 1965 crop has been retarded and it may be impossible to take off the crop which would have to stand over to 1966.

U.S. sugar cane crop[2].—Mainland sugar cane production in 1964 was 14,171,000 tons or about 2·6% above the record year of 1963. The increase in production was the result of expanded areas, as yields in Florida were about the same level as in 1963 while the Louisiana yield was lower owing to hurricane damage in October.

[1] C. Czarnikow Ltd., *Sugar Review*, 1965, (699), 35.
[2] *Public Ledger*, 24th December 1964.

SUGAR INDUSTRY TECHNICIANS INC.

George and Eleanore Meade Award

At the Executive Committee Meeting of Sugar Industry Technicians Inc., held on the 19th January, recommendations regarding the "George and Eleanore Meade Award" were read by the President, W. A. BEMIS, and adopted with slight amendments. Below is the basis of the award to be given subsequent to the 1965 Technical Session. An award will henceforth be made upon this basis until changed by the Executive Committee.

(i) The name shall be the "George and Eleanore Meade Award".

(ii) It will be given for the best paper presented at the Annual Meeting of S.I.T. Any decision as to what constitutes the "best" paper will take into account interest, format, and presentation, but the Committee will not be governed exclusively by these qualities.

(iii) It will consist of a cash award and a suitable certificate.

(iv) The cash award for the 1965 session will amount to $100 and will be for the one best paper; however, the Committee reserves the right to divide the award if papers of equal merit are presented.

(v) The selection of the award winner and cash prize will be made by the "George and Eleanore Meade Award" Committee.

(vi) The Committee shall consist of the Second Vice-President as Chairman, plus the Chairman of the Honorary Award Committee and of the Programme Committee. Both of the Chairmen, as well as the Second Vice-President, are to be the outgoing Officers as of the time of the Annual Meeting.

(vii) The selection of the award winner shall be made by the Committee as soon as possible after the final paper of the session has been presented. This will necessarily be after the Annual Meeting.

(viii) The award will be made by mailing a cheque and a suitable certificate to the member accompanied by a letter of transmittal from the outgoing President. The Award Committee will have the responsibility of obtaining such certificate.

(ix) A suitable record of the award will be included in the annual proceedings.

(x) The Publication Committee will be supplied with sufficient data and material to enable them to make arrangements for adequate publicity in the sugar journals.

(xi) The Chairman of the "George and Eleanore Meade Award" Committee will send to Dr. and Mrs. Meade an announcement of its selection with a suitable letter of thanks.

Stock Exchange Quotations

CLOSING MIDDLE

London Stocks (*at 17th February* 1965)	s d
Anglo-Ceylon (5s)	7/7½
Antigua Sugar Factory (£1)	12/–
Booker Bros. (10s)	19/–
British Sugar Corp. Ltd. (£1)	21/3
Caroni Ord. (2s)	2/3¾
Caroni 6% Cum. Pref. (£1)	15/9
Demerara Co. (Holdings) Ltd.	4/6
Distillers Co. Ltd. (10s units)	24/1½
Gledhow Chaka's Kraal (R1)	20/–
Hulett & Sons (R1)	30/–
Jamaica Sugar Estates Ltd. (5s units)	4/–
Leach's Argentine (10s units)	21/7½
Manbré & Garton Ltd. (10s)	38/9
Reynolds Bros. (R1)	21/–
St. Kitts (London) Ltd. (£1)	17/6
Sena Sugar Estates Ltd. (5s)	6/9
Tate & Lyle Ltd. (£1)	32/9
Trinidad Sugar (5s stock units)	3/2½
United Molasses (10s stock units)	26/3
West Indies Sugar Co. Ltd. (£1)	9/3

CLOSING MIDDLE

New York Stocks (*at 16th February* 1965)	$
American Crystal ($5)	17¼
Amer. Sugar Ref. Co. ($12.50)	21
Central Aguirre ($5)	24½
Great Western Sugar Co.	37¾
North American Ind. ($10)	14
South P.R. Sugar Co.	31⅛
United Fruit Co.	17¼

Brevities

Fletcher & Stewart mills for Colombia[1].—Fletcher & Stewart Ltd. have recently received an order for a set of heavy-duty cane knives and two mills with gearing and rubber belt intermediate carriers. The mills will be added to the existing American-supplied tandem at Manuelita S.A. and when brought into operation will raise crushing capacity to 3000 tons per day. Plans are already in hand for further extension to 4500 tons per day in a few years' time.

* * *

Bagasse pulp project in Hawaii[2].—C. Brewer & Co. is conducting a study of the defunct Canec wallboard plant in Hilo to determine the possibility of coverting the facility to a bulk pulp manufacturing operation.

* * *

Uruguay sugar mill proposal[3].—A delegation of Spanish businessmen visiting Montevideo in early December offered to install a sugar mill for the Instituto Nacional de Colonización.

* * *

New beet sugar factory for Chile[4].—Sociedad de Fomento Agricola de Temuco, Sociedad Industrial de Temuco, Camara de Comercio de Temuco and farmers of Cautin Province have recently organized a private corporation to build and operate a beet sugar factory and refinery in Temuco. The plant will have an initial production capacity of 7000 metric tons of sugar per year, to be increased eventually to 20,000 tons.

* * *

Pakistan sugar factory order[5].—Mipurkhas Sugar Mills Ltd. of Karachi have placed an order with Fletcher & Stewart Ltd. for their new sugar factory at Jamrao near Karachi. It is to be in operation toward the end of next year and will produce white sugar by the double carbonatation and double sulphitation process.

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[1] F. O. Licht, *International Sugar Rpt.*, 1965, **96**, (36), 17.
[2] *Sugar y Azúcar*, 1964, **59**, (12), 44.
[3] *Fortnightly Review* (Bank of London & S. America Ltd.), 1964, **29**, 1089.
[4] *Sugar y Azúcar*, 1964, **59**, (12), 45.
[5] F. O. Licht, *International Sugar Rpt.*, 1965, **96**, (36), 18.