USES FOR EXCESS AND NON QUOTA SUGAR

By J. B. ALEXANDER

During recent years the international sugar pendulum has shown a rather alarming tendency to swing outside the limits normally acceptable to the producer on one hand, and the buyer on the other. It seems reasonable to conclude that the climate is right for the re-introduction of an international quota agreement in the not too distant future; the position might thus conceivably arise that South Africa has more land under cane than can comfortably accommodate the requirements of internal consumption and a foreseeable export.

The question would then arise of the policy to be adopted. Should any excess cane be ploughed out with the possible danger that the following year could again bring another shortage due to fire, flood, drought or miscalculation? If the answer is to be in the negative then we should look at alternate uses of excess sugar cane.

In considering other uses I will exclude those where juices or syrups are converted directly by chemical or fermentive processes to non-sugar products. There remains, then, the category of products classed as 'non-centrifugal sugars'. Several such products were recently produced by Natal factories in what could probably best be described as large pilot plants, but the rapid rise in the world price of sugar soon caused interest in these investigations to dwindle and eventually to be lost in the upsurge of increased sugar production.

High Test or Invert Molasses

One of the most successful outlets in the past for non-quota cane has been the export of high test molasses from Cuba to the United States of America. As far back as 1939 this export of high test molasses had already reached a figure equivalent to 350,000 tons of raw sugar, and the sales of total sugars in this form far exceeded that sold in the form of blackstrap or final molasses.

Whereas invert molasses was formerly used mainly in distilleries where its high sugar content made it more valuable than final molasses, it is presently used largely for biological process, such as citric acid and antibiotic productions where its low non-sugar content gives it a distinct advantage over final molasses.

Methods of Production

Invert molasses is basically a high purity syrup in which a large proportion of the sucrose has been inverted to permit its concentration and transport without the danger of crystallisation. Production in Cuba was confined to raw sugar factories where the standard procedure was to invert raw syrup leaving the evaporator (at about 53° Brix) to an extent of 60-80%.

The use of mineral acids for inversion was soon superceded by the use of yeast invertase, which resulted in less damage to equipment and at the same time a higher yield in sugars. A further disadvantage at present applying to the use of acid inversion is that many users of invert molasses resort to ion-exchangers and therefore consider the additional ash as a serious defect in their raw material. In Cuba, after inversion which usually took place in crystallisers, the syrup was concentrated in an ordinary pan to 85° Brix and passed through suitable heat exchangers for cooling to below 45° C. for storage.

During manufacture of invert molasses in a raw sugar factory, the complement of process workers can be considerably reduced due to a simplified process.

It is of course possible to achieve the same result by inverting raw sugar solutions and then adding final molasses till the concentration of non-sugars reaches the desired level.

Typical Specification

Although individual users may have special requirements, the following is typical of the analysis acceptable to large users in the United States of America:

Refractometric Brix	85°
Sucrose	27%
Reducing Sugars	50%
Sulphated Ash	2.5% (maximum)
Water	16%
Total Sugars	78%
Non-Sugar Solids	6–8%
Iron	60 ppm (maximum)

In cane growing countries with tropical climates there would appear to be little difficulty in meeting this specification. When using Natal sugar liquors in laboratory tests it was found that their inherent high ratio of ash to non-sugar solids led to difficulty in holding the ash below 2.5% and at the same time the non-sugar solids in the 6-8% range.

The same difficulty was found to apply to invert molasses synthesised from Natal raw sugar and molasses as can be seen from the calculated requirement of raw sugar and refinery molasses for the manufacture of a shipment of 10,000 tons of invert molasses, as follows:

	Raw Sugar	Molasses	Invert Molasses Produced
Weight required	6,631 tons	2,022 tons	10,000 tons
Solids %	99.65	73.2	83.3
Sucrose %	98.4	37.2	23.8
Reducing Sugars %	0.3	9.3	53.5
Ash %	0.4	12.3	2.75
Non-Sugar Solids %	0.95	26.7	6.03
Total Sugars	103.6	48.4	77.3

By the choice of a factory with a lower ash to non-sugar and ash to total sugar ratio, a far more favourable ratio of raw sugar to molasses could be obtained.

In fact, it would appear that the most favourable time for a raw sugar factory to produce invert molasses in Natal would be when the boiling house recovery is likely to be low. The use of a factory for invert molasses production during normal off-season is likely to present a far more attractive proposition than it would were the factory used for conventional raw sugar manufacture.

Some Advantages and Disadvantages to Invert Molasses Production

Advantages

1. High test molasses is normally regarded as non-quota sugar.
2. Since high test molasses is normally purchased on a total sugars content basis, all sugars (both sucrose and reducing sugars) which would be 'lost' to molasses are paid for at full price.
3. Due to the fact that inversion (hydrolysis) of 100 parts of sucrose yields 105 parts of invert sugars by the uptake of water, there is a further 'gain' in sugars of up to 5% on sucrose, providing inversion is carefully controlled.
4. Production of high test molasses involves a simpler process than raw sugar manufacture and requires less labour, less fuel and a minimum of additional equipment.
5. The use of low purity juices in the beginning or end of season periods could be considerably more suitable for high test molasses than for raw sugar manufacture.
6. The method of conveying high test molasses is simple as it can be pumped.
7. Invert molasses could prove a valuable competitor to other sweeteners and high purity fermentables on the local market. The availability of invert molasses could even stimulate new local industries.

Disadvantages

1. The inherent high ash to non-sugar ratio of most Natal sugar syrups could cause difficulties in adhering to a strict specification in this respect.
2. Since it is not normally profitable to consider shipments of less than 8,000 tons, suitable storage for this quantity must be obtainable within pumping distance of tanker berths.
3. At least 21% of water and non-sugars must be transported compared with less than 3% non-sucrose in raw sugar.
4. An additional cost of inversion estimated at less than 50 cents per ton would be incurred.
5. A surplus of bagasse could prove an embarrassment to some mills.

Dehydrated Cane Juice (D.C.J.)

Dehydration of cane juice at low cost is not quite as simple as one might imagine. Spray drying can be achieved only with difficulty and the standard commercial units do not have the throughput or economy required to match the capacity of today's raw sugar mills. In the late 1950's a small plant in Cuba (operating on an unknown process) apparently sent small batches of dehydrated cane juice to the United Kingdom and the United States of America for trial purposes. The results of these tests evoked considerable interest. Requests for the manufacture of a similar material in South Africa led to the development of plant at Amatikulu capable of producing dehydrated cane juice at up to five tons per hour.

Processing Data

Mixed juice is limed and concentrated in the normal multiple effect evaporator without settling. The syrup from the evaporator is then fed to a vacuum pan where it is concentrated to as low a moisture content, without crystallisation, as is practically possible. This is achieved by increasing the boiling temperature as evaporation progresses. The concentrate, with a Brix usually in excess of 90°, is then dropped into a holding vessel. Hot concentrate from this vessel is sprayed onto a back-mix in a continuous mixer. The back-mix has the effect of spreading and cooling the concentrate so that it emerges from the mixer as suitable feed for drying, which forms the next step.

After drying to a moisture content of about 3%, the material passes through a cooler to a bin for bagging and recycling. A portion of the material from the bin is recycled to provide back-mix, thus the back-mix consists of finished product together with a small addition of starch to reduce caking during storage.

At Amatikulu, in order to run the production in parallel with that of normal raw sugar, syrup and unfiltered mud were mixed in a calculated ratio to reconstitute concentrated, unsettled, limed mixed juice. A lower purity product was also manufactured by mixing A molasses with mud from the clarifier. This latter mixture gave greater difficulty in processing, but raised the interesting possibility of producing a dehydrated feed product in parallel with the out-turn of a raw sugar originating from A strikes only.

Since the Relative Equilibrium Humidity of dehydrated cane juice varies directly with its moisture content, it is preferable to bag it in containers with some moisture barrier, such as a polythene liner, if it is likely to be stored for any period under varying conditions of humidity.

Analysis of Dehydrated Cane Juice

Dehydrated cane juice is essentially carbohydrate—the main constituents being sugars. A broad specification for this product, made under South African conditions, is as follows:

Total Sugars	85%	(minimum)
Protein (crude)	1%	
Moisture	3.5%	(maximum)
Minerals	3.5%	
Fibre	0 5%	
Starch Equivalent	90%	(minimum)
Particle Size	3/16"	(maximum)

Properties and Uses

Due to its high sugar content, this product can be used as a valuable, high energy sweetening agent in starter feeds.

In common with humans, the young of many animals are very partial to sweetened food, and since it is recognised that the conversion of feeds consumed directly by the young animal is far higher than their conversion via the mother, the practice of sweetening starter feeds is increasing. This practice has found favour with the sweetening of starter feeds for calves and lambs, but has probably been most popular with pig breeders.

The scouring effect produced on animals fed large quantities of molasses containing a high percentage of mineral matter is recognised as one of the main limiting factors in its use. D.C.J., with less than one third of the mineral matter, and with a greater palatibility, does not suffer this same disadvantage.

Another case where the palatibility of D.C.J. is important is the feeding of urea to ruminants. Here too, the soluble carbohydrate content makes this product an ideal partner to today's cheapest protein equivalent. The binding properties of D.C.J. have also been used to advantage in the production of licks or blocks used in limiting the intake of urea. This same binding property may be of advantage in cubing or pelletising.

The low fibre content of D.C.J. contributes to its high digestibility when fed to poultry — a factor which is of particular importance in the economic production of broilers.

In the production of silage, a field in which there has been renewed interest, D.C.J., with its high content of fermentables appears to have much to recommend its use.

Some Advantages and Disadvantages in the Production of Dehydrated Cane Juice

Advantages

1. Being a 'non-centrifugal sugar' D.C.J. will be classified on a non-quota basis.
2. The field of animal feeds has an enormous potential which could provide an off-take of much additional cane.
3. The full scale production of D.C.J. would result in no out-turn of filtercake or molasses.
4. In common with invert molasses, the production of D.C.J. is a basically simpler process than that of raw sugar, and gives a higher yield of the final product.
5. The high purity, low reducing sugar content of Natal juices is likely to permit dehydration with greater ease than in some of the more tropical countries.
6. Since D.C.J. is in a solid state, its transport and distribution for agricultural purposes provides for much simpler handling than in the case of molasses, where the use of drums is necessary.

Disadvantages

1. D.C.J. is a relatively unknown material which would require a thorough technical and promotional sales programme.
2. The caking tendency of D.C.J. requires additional expenditure on labour, starch and packing material.
3. Low purity juices tend to dehydrate with difficulty and slow down production.
4. Although clarifiers, centrifugals and other equipment would not be required, additional equipment in the form of mixers, dryers and coolers, etc., would be necessary.
5. The bulk density of D.C.J., as produced, was less than raw sugars.
6. The dark colour of D.C.J. prejudices its use in some balanced mixes.

Quantities Produced compared with Raw Sugar Production

The following basic data, taken from the industrial averages for the 1963-64 season, have been used to calculate the production of Invert Molasses and D.C.J. for comparison with the actual raw sugar production achieved:

Sucrose % Cane	13.55%
Sucrose Extraction	94.08%
Purity of Mixed Juice	85.3
Boiling House Recovery	89.6%

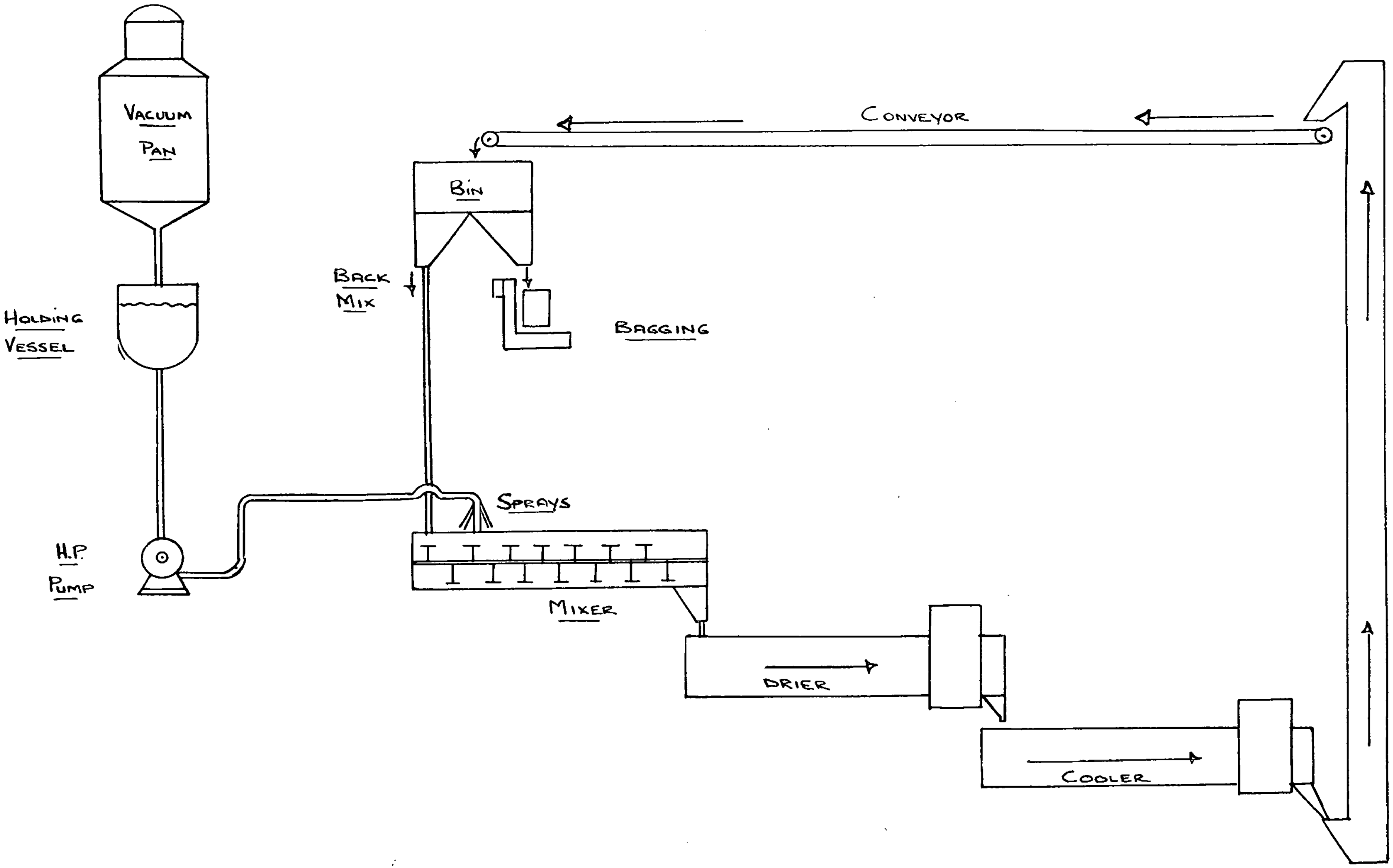
Therefore the quantities of finished product obtainable from 100 tons of cane, and for comparison, converted to a percentage raw sugar basis is as follows:

	Tons Product from 100 Tons of Cane	Product as a Percentage of Sugar
Raw Sugar (Pol 98.5°)	11.59	100
Invert Molasses (Assuming a 2% loss)	18.24 (13.8 T.S.)	157.3 (119.3 T.S.)
Dehydrated Cane Juice (Including 0.5 tons of starch)	16.06	138.4

Summary

An outline is given of the methods of production and uses of Invert Molasses and Dehydrated Cane Juice, together with some of the advantages and disadvantages attendant on both processes.

FLOWSHEET FOR DEHYDRATION OF CANE JUICE.



Mr. Boyes: In 1961-62, the years of quota restriction, the South African Sugar Association gave a grant to Tongaat to explore the manufacture of jaggery, using methods more efficient than those being used at that time in India.

Crusher juice was treated with lime and phosphoric and then settled in a decanting vessel. The decanted juice was boiled in open vessels at atmospheric pressure, and this part of the process took some time to perfect. The heavy syrup was run into moulds and stirred vigorously to get more evaporation and supersaturation, and it then set rock-hard.

In the decanting stage there was a lot of precipitated material which could not be wasted and it was mixed into final molasses or B-molasses.

The colour of the jaggery was very yellow and the preference was for a white colour.

The plan appeared economically feasible at first as a big demand was anticipated by the Indian people in South Africa at a selling price of 15c per pound.

The local demand was disappointing, mainly owing to the colour of the product.

It was easy to find export markets, particularly in the East, and an enquiry for 10,000 tons was received. However, in the East jaggery sells at less than the price of sugar, and this accounts for its popularity. There was therefore no profit in the export market.

At this stage quota restrictions were removed and interest in jaggery ceased.

Dr. Douwes Dekker: The difficulty in making invert molasses is the necessity of meeting the requirement that maximum ash content should not exceed 2½ per cent. Our cane juice has such a high ash content that it would be practically impossible to make the right type of invert molasses.

Dr. Dodds: Although it is important to find other uses for sugar because of possible surplus of product it is also important because of the enormous competition that sugar is now meeting from non-sugar sweeteners, particularly in the United States.