ABSTRACT

Several Venezuelan sugar mills have found that it is economically justifiable to produce 70°Bx syrup instead of sugar which is trucked to conventional sugar factories for its processing. Syrup mills require less investment, considerably fewer personnel and have a relatively trouble-free operation. The reasons for the adoption of this scheme are explained and information is given about syrup storage and some of its problems.

INTRODUCTION

An interesting innovation in sugar manufacture has been successfully adopted by a group of Venezuelan sugar factories. The novelty consists in the operation of cane mills that produce syrup only instead of sugar. The syrup is trucked to conventional factories for its processing into refined sugar.

BACKGROUND

Some fifteen years ago the Holly Sugar Co in the United States thought of a new way to lower the investment required to increase the capacity of a beet sugar factory. The idea consisted in expanding the capacity of the first part of the plant only (slicing, juice extraction, clarification and evaporation) storing the excess syrup and processing it at the end of the beet campaign.

For this purpose Holly Sugar has developed a method of storage that allows them to keep large volumes of 70°Bx syrup for several months with insignificant losses of sucrose. The Carlton plant of Holly Sugar in Southern California was expanded in 1960 from a slicing capacity of 4,000 tons of beet per day to 6,000 tons without increasing the size of the sugar end, by installing 5 storage tanks with an individual holding capacity of 11,000 tons of 70°Bx syrup.

The scheme proved so successful that Holly Sugar built a new plant at Hereford, Texas in 1967, incorporating from the start syrup storage facilities, and several other beet sugar companies both in the United States and Europe have followed Holly Sugar's example.

APPLICATION TO THE CANE SUGAR INDUSTRY IN VENEZUELA

In 1964 Central El Palmar, a Venezuelan sugar mill, thought of applying to the cane sugar industry the idea of syrup storage with a different purpose from that of Holly Sugar. The objective in this case was to simplify the operation, and reduce the operating costs, of a cane sugar factory too small to function profitably as a conventional sugar mill.

At that time all Venezuelan sugar factories operated integrated refineries and produced refined sugar only. With rising salaries and other costs the operation of the smaller plants had become unprofitable. This was the case of
Central Tuy with a daily grinding capacity of only 700 tons of cane per day and a yearly production of 5,000 tons of refined sugar in a 4-month crop. Central El Palmar had acquired an interest in this small mill and thought of reducing its operating costs by converting it into a syrup mill. Syrup of 70°Bx would be trucked from Tuy to Palmar, a distance of 120 km, and processing would be effected in the larger plant which had then a daily grinding capacity of 6,000 tons of cane per day and a yearly production of about 80,000 tons of refined sugar.

As it was expected that some syrup storage would be required to absorb surges in production, the keeping stability of 70°Bx cane syrup was tested in several experiments where syrup was stored in 200-litre steel drums and in two 420-hectolitre crystallizers of Central El Palmar.

The experiments proved that 70°Bx syrup had sufficient stability to permit the adoption of the proposed scheme. Central del Tuy was thus converted from a sugar factory producing refined sugar into a syrup mill. Its staff was reduced to about one third. Two of the vacuum pans were and are still used to concentrate syrup from the density attained in the evaporator to 70°-72°Bx. The former crystallizers are used as holding tanks from which tank trucks are loaded. A 2,000 ton holding tank was erected at Palmar for surge storage. Two more tanks were added later.

Syrup is processed at Palmar whenever capacity is available. This occurs when the rate of grinding is reduced for any reason or when the milling tandem stops for causes such as week-end maintenance, rain or a breakdown. The result is that the sugar end at Palmar is always working at full capacity and processing the additional syrup is done at a relatively low cost. The additional fuel consumed and the syrup freight are more than compensated for by the reduction in labour cost, the simplicity of the operation of the syrup mill and the higher recovery attained by processing the syrup in the larger plant.

Syrup is weighed, sampled and analysed when it is received at the processing plant and the available sugar and molasses are calculated from these data.

The conversion of Central Tuy from a conventional sugar factory into a syrup mill was so successful that another small plant, Central Mérida, followed its example soon afterwards, sending its syrup to Central Motatán located in the same area. When a new factory was planned in 1968 for another sugar company, Central La Pastora, it was suggested that a syrup mill be built instead of a conventional plant and its syrup sent to other factories for processing. The idea was accepted and a syrup mill with a grinding capacity of 1,000 tons of cane per day was installed with provision for its future expansion to 3 times this capacity and the addition of the sugar end if desired. The investment required for the new plant was thus considerably reduced, its start-up was effected with a minimum of difficulties and it has since had a trouble-free operation with a very low down time in spite of the fact that the plant is located in a rather remote area where skilled personnel are not available. In the 1975 crop La Pastora will produce the equivalent of 25,000 tons of sugar in syrup which is processed at 3 different factories, Yaritagua, El Palmar and Motatán. Central La Pastora has operated with a profit since its second crop and its present return on investment is considerably greater than that of a conventional sugar plant. In 1974 its grinding capacity will be increased to 2,000 tons of cane per day.
There are 4 new syrup mills planned for Venezuela. Two are already under construction and 2 more are in the planning stage.

**Cane Syrup Storage**

At present Central El Palmar has 3 syrup storage tanks with a total holding capacity of 10,000 tons and Central Yaritagua has storage facilities for 9,000 tons of syrup. They are plain steel tanks painted inside with an epoxy enamel. The bottom has a 3-degree slope towards the central outlet to facilitate the liquidation of the contents. The tanks are equipped with fans for forced ventilation with air heated about 5 degrees above ambient temperature to prevent condensation of moisture that would occur with the outside changes of temperature.

Syrup has been kept in storage in appreciable volumes for up to 3 months and experimentally in small volumes up to 8 months. In general syrup keeps well for about 4 to 6 weeks. After that time some foaming may be observed and a drop in pH from 6.5, which is the pH of fresh syrup, to around 4.0. This takes place in a few days. Then foaming disappears and a slow inversion of sucrose occurs as a result of the low pH. The rate of sucrose loss is approximately 0.5% per week at an average ambient temperature of 27°C. During the short period of foaming (5 to 7 days) a drop in the content of reducing sugars has been determined. Afterwards the content of total sugars remains constant. Looking at diluted samples of syrup under a microscope during the foaming period the presence of some type of osmophylic yeast, that grows in the form of chains, has been detected. All this leads us to speculate that the cause of foaming, with loss of reducing sugars and a drop in pH, are the result of the activity of this micro-organism that probably converts sugar into acids and that ceases to multiply at the lower pH where inversion of sucrose occurs. The possibility that the destruction of reducing sugars and foaming of the syrup, which is due to carbon dioxide formation, are caused by a purely chemical reaction, such as the Maillard reaction, has also been considered.

Another important feature of stored syrup is the formation of a sludge in the bottom of the tanks. This sludge consists of the suspended matter present in the original syrup and of very fine crystals of calcium sulphate that slowly precipitate during the period of storage. The best way to deal with the sludge when the processing mill is still grinding cane is to mix it with the limed juice going to clarification. If cane crushing has stopped the sludge must be processed with the rest of the syrup at a reduced rate of operation.

**Conclusion**

The operation of syrup mills in Venezuela has proved to be a good solution for plants too small to operate economically as conventional sugar factories and for new plants which can be started at capacities that would be too small to be profitable as complete factories. The simplicity of operation of syrup mills makes them very suitable for plants located in remote areas.

The possibility of storing cane syrup for several months with only insignificant losses is very attractive. This permits the building of more syrup mills and the operation of the sugar end of the conventional factories, the majority of which operate for only six months in Venezuela, for most of the year. The
management and the technical personnel of Central El Palmar and Central Yaritagua think that this can be done and they are searching for a solution to the problem. Small quantities of syrup have been kept without any losses for over a year in sealed containers and also in open drums under refrigeration at about 10°C.

It is interesting to mention that in sugar areas where it is possible to crush cane all through the year and where sugar factories usually shut down on week ends the sugar end of these plants could operate continuously, receiving syrup from other mills. Syrup would only have to be stored for a week and it would be easy to hire shift personnel to operate the sugar end of the factories for the seven days of the week.

REFERENCES

OPERACION DE INGENIOS MELADORES EN VENEZUELA
F. Cordovez Z.

RESUMEN
Varios ingenios venezolanos han encontrado que es económicamente interesante producir meladura de 70°Bx en lugar de azúcar la cual es transportada a factorías azucareras convencionales para su procesamiento. Los ingenios meladores requieren menor inversión, mucho menos personal y operan con un mínimo de problemas. Se explican las razones para la adopción de este sistema y se da información sobre el almacenamiento de meladura y algunos de sus problemas.