How Beet Sugar is Made

Written for The Western Home Monthly by Max McD.

SUGAR belongs to the force producing foods and is of great importance as an article of diet. It is estimated that in America about eighty pounds of sugar is consumed a year per capita of population. This sugar is obtained in three ways—from the stems of plants, as cane sugar; from sap of trees, as maple sugar; and from tubers, as beet sugar.

Cane sugar was probably known in very early times, but it was not till the fourteenth or fifteenth centuries that it became a common article of food even among the higher classes. Maple sugar is used chiefly as a luxury. It is made from the sap of the maple tree, the bark being tapped in the early spring, when the sap is flowing upward.

More than half the world's sugar is made from beet root. To the chemist this is identical with cane sugar, and the consumer is unable to detect any difference, but beet sugar is slightly less sweet than the best grades of cane sugar. The object of this article is to tell how this grade of sugar is made. In its manufacture the raw sugar beet enters the factory at one end, passes through process after process, and comes out at the other end the perfected sugar of commerce. The entire operation is completed in less than 36 hours.

Thorough Washing is the First Operation

From the storage bins the beets are allowed to fall into a flume of water which floats them into the factory where they enter an elevator or beet wheel and are carried to a cleaner. Here they are subjected by means of propeller arms to a thorough washing, and are automatically ejected into another elevator which carries them to the third floor, where they fall into a slicer. The slicer consists of a driving pulley that operates a shalt carrying a circular frame holding a set of knives. In the slicer they are cut into long V-shaped strips about five and a half inches wide by one-eighth inch thick and of various lengths. The slices of beets are called cossettes.

From the slicer the cossettes are transported by gravity through a hopper and chute to a diffusion battery. The vessels for diffusion are mostly up-right iron cylinders with flat or arched bottoms, having a large opening capable of being tightly closed for receiving the cossettes. A number of such diffusers connected together is called a battery. In order to keep the contents at the required temperature, there is connected with each diffuser, a heater, which reheats the juice before it is admitted to the next diffuser in line. These vessels are connected by means of pipes in such a manner that the same portion of liquor can be driven through the entire battery. The driving power is hydrostatic pressure and is obtained from a tank or cistern in the upper story of the sugar house, giving a pressure of from fifteen to twenty-five pounds per square inch. Here the sugar is extracted by a series of bleachings with hot water and is held in solution in the cells of the beets.

Lime Used in Clarification

The object of the diffusion process is to obtain the sugar with as few impurities as possible. When sufficiently concentrated the juice is drawn off and measured into tanks, enough being taken to extract the sugar without too great dilution. This is accurately measured and a record kept of the time, number of cells, and density. The juice is then pumped into a calorisator where it is heated. It is necessary to coagulate all albuminoids before the pressure of lime, and this operation is very important.

From the heater the juice flows to carbonators which are covered tanks heated by closed steam, where, to the heated juice, is admitted milk of lime. This lime combines with the greater part of the impurities and forms an insoluble precipitate. The lime also combines with the sugar forming calcium sucrate, which if not decomposed would be lost during filtration. Decomposition is accomplished by injecting gas made by burning the lime used in clarification thus forming an insoluble precipitate of calcium carbonate. Just enough gas is admitted to break up this combination of lime sugar. Care is taken not to carry the operation too far, as after the calcium sucrate is destroyed the carbonic acid attacks the compounds of calcium and in time will liberate all impurities again.

This process is closely watched and samples are taken every few seconds. The proper point at which to stop the flow of gas is indicated by the formation of a granular precipitate showing clear liquor between the particles. The gas is instantly shut off, a test sample is sent to a table near by, where a chemist's assistant is stationed, and the percentage of lime in the juice determined by filtration with standard acid.

Juice Must Pass Through Filters

After clarification (or carbonation as it is called in a beet sugar house) the whole contents of carbonate juice and precipitate are drawn off and forced through filter presses by means of a pump. The presses are composed of alternating solid and hollow openings in either side, to allow the juice to pass from one to another These are hung on two side beams, which, with the head and tail pieces form a rack, supporting the frames. The solid frames are covered with two thicknesses of cloth manufactured especially for this purpose and when these alternating solid and hollow frames are clamped by means of a screw, and the carbonator juice pumped through a valve, it is readily seen that a cake will accumulate on the cloth in filling the hollow frames and clear juice run through the cocks into the troughs. When the press is full of cake, hot water is forced through the cake, thus washing out any remaining juice. The press is opened by releasing the pressure of the screw, the apron is removed and the cake dropped through a hopper underneath and conveyed outside the building. This refuse can be used as a fertilizer.

The physical condition of the precipitate is important. If the operation has been carried on properly the juice will filter rapidly through the presses leaving a hard porous lime cake that is easily cleared away. The juice from these filter presses is received into another set of carbonators where milk of lime is again added. This time there is not so much danger of over carbonation, the gas passing through the juice until there is no trace of lime remaining. This is determined by actual test each time. The juice is then boiled to precipitate the double carbonate that may be in the solution, and again forced through another set of filter presses.

Sulphur Fumes Clean Juice

The clear strained juice which is now a light straw color is pumped to sulphitors. The operation here is performed in tanks of precisely the same construction as the carbonation tanks, sulphur fumes instead of gas being forced by air pumps through the perforated pipes into the juice, as in decalorizing it, and precipitating the remainder of the lime.

The juice, which is now water white, is allowed to flow through mechanical filters, which eliminate whatever mechanical impurities remain in the juice. At this stage, the juice while comparatively pure, is diluted, containing only a small amount of sugar depending on the quality of the beets worked. It is desirable to concentrate it and this is done in a multiple effect evaporator. This consists of four bibies, each of which is arranged with steam chambers and tubes, with room for this vapor to disengage. The upper part of the vapor chamber is connected with the steam chamber of the next body, so that the vapor from the boiling liquor may pass into the steam chamber of the next. The juice going in at a density of about 100 and flowing through the effects becomes more condensed as it passes along. This not only concentrates the sugar but also the impurities.