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DRYING AND COOLING IN SUGAR PROCESSING

During sugar processing, the cooling and drying of crystalized sugar is the most important step after the purification process to guarantee a high quality of finished product. Sugar drying removes excess moisture from the sugar using heat, while cooling the sugar brings it to an ideal temperature for storage and transport. Without processing sugar in this way, clumping and discoloration during storage would occur, degrading the quality and value of the final product.

The history of sugar processing

The origin of sugar processing can be traced back to the early civilizations in New Guinea, Southeast Asia, Southern China, and India. The first organized sugar production began in India as early as 350 AD[1]. The cultivation of sugar has a rich history beginning during the Crusades and continuing through to settlement of the Caribbean Islands, Central America, and South America.

In the late 18th century, German scientist Andreas Marggraf discovered that sucrose could be extracted from beet root, leading to the first sugar beet processing factory in Poland. British blockades of sugar cane during the Napoleonic Wars, ultimately stimulated the rapid growth of the European sugar beet industry. Sugar processing, traditionally a labor intensive process, became more mechanized and efficient in the 18th century with the introduction of the steam engine. Today the sugar industry is thriving worldwide, with sugar production reaching 175.1 million metric tonnes in 2015[2].

What sugar is, how it is processed

Sugar (sucrose) is a natural carbohydrate found in most plants. All green plants manufacture sugar through the process of photosynthesis, but only sugar cane and sugar beet contain it in sufficient concentrations for efficient extraction.

Sugar is processed into a few different final forms. Granulated (crystalline) sugar, the most commonly-used sugar in households, is essentially pure sucrose and is naturally white. Icing sugar is powdered granulated sugar, typically with a small amount of cornstarch to prevent caking. Brown sugar is granulated sugar that includes molasses (either added back to granulated sugar or left from unrefined sugar), which gives it its distinctive colouring.

Sugar cane vs. sugar beet

Sugar is the same composition whether it is extracted from sugar cane or sugar beet.

Sugar cane is a tropical grass that grows between 10 and 30 feet high. The stalks contain 12% to 14% sucrose. The main producers of sugar cane are Brazil, China, Mexico, Australia, Thailand, and the United States.

Sugar beet is found in temperate climates, with the highest producers being the European Union, Russia, Turkey, Japan, China, and the United States. The beet root contains 16% to 20% sucrose.

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[1] History of Sugar. (n.d.). Retrieved June 8, 2016 from http://www.sugarhistory.net/who-made-sugar/history-of-sugar/

[2] The Statistics Portal. (2015/16). Sugar Production Worldwide [Statistic]. Retrieved June 8, 2016, from http://www.statista.com/statistics/249679/total-production-of-sugar-worldwide/

Sugar processing

Fundamentally, sugar processing is very similar between both sugar cane and sugar beet. The main differences between both processes are the way the juice is extracted and purified. In the case of sugar cane, the natural sugar is found in the stalk, while in the sugar beet, it is found in the root. The sugar cane stalk is cut and shredded before the extraction of the juice which takes place by squeezing mills or hot water diffusers. The sugar juice is purified to remove any remaining plant fibers or soil. For the sugar beet, the root is cut into slices called cossettes. The cossettes then enter a diffusion tower for the extraction and purification process. In both instances, the sugar juice is concentrated by evaporating water until it reaches a thicker syrup state. The syrup is fed to the crystallizers where sucrose crystals grows, resulting in a mixture of sugar and molasses. Finally, large rapidly spinning centrifuges separate the crystals from the molasses before being dried, cooled, and stored. Raw sugar can be produced in a very similar way with less purifications stages, and then transported to the sugar refinery where it is melted, filtered, and purified before crystallization occurs again.

Sugar refining equipment

Traditional sugar drying with rotary drums

Rotary drums are the most common method for drying sugar, as they are suitable for a variety of sugars and variable feed conditions. Rotary drums are a reliable, long term solution for drying sugar that helps keep the product from caking. Additionally, rotary drums are available in stainless steel, a requirement for many food production facilities. To operate, countercurrent air flow moves along the long, cylindrical drum to dry the sugar. Heated air can be fed into the dryer through a centralized pipe to further control the drying effect.

Fluidized bed coolers are also a common solution for cooling sugar. In this process, the crystalized sugar is moved in a current of whirling air from the intake feeder to the discharge end. Large volumes of air from powerful fans are used to fluidize the material, enabling it to flow from one end to the other, cooling the sugar as it moves. This method allows the sugar to be cooled to a specific temperature. Fluid beds do require an important air treatment system to comply with the local regulations.

Commonly, we are seeing a combined drum system, with the first drum operating as a dryer and the second drum operating as a cooler. Alternatively, sugar processing facilities can use a combination of a rotary drum dryer and fluid bed cooler, where air exhausted from the fluid bed cooler can then be used in the rotary drum dryer, reducing the amount of air required in the process.

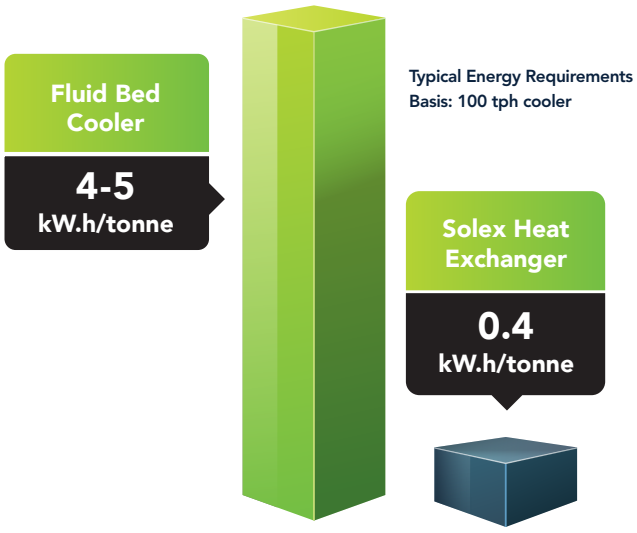
New sugar drying technology

A much more efficient sugar cooling process has been developed over the past 15 years, changing the face of the sugar processing industry. Using thermal conduction and the science of vertical mass flow, Solex heat exchangers have made the sugar cooling process much more efficient.

In a Solex heat exchanger, sugar flows vertically between a series of hollow stainless steel plates that are cooled by cold water flowing countercurrent through the plates. The product does not come into contact with air or water; it is cooled by conduction as it slowly flows vertically between the plates, resulting in a stable end product ready for storage or transport.

In comparison to the fluid bed coolers and rotary drum coolers, which typically consumes around 5 kW.h/tonne of sugar, the Solex heat exchanger's average consumption is 0.4 kW.h/tonne of sugar, making it the most energy efficient sugar cooling solution available. Additionally, since the sugar does not come in contact with air or water, the risk of bacterial, odor and moisture contamination is eliminated. The risk of product degradation is also removed due to the slow, controlled movement of sugar through the unit.

The Solex heat exchange unit can easily be retrofit into existing sugar processing facilities, as it has a small installation footprint and can be used in conjunction with current equipment. For example, the Solex unit can operate as a secondary cooler after the existing fluid bed or drum cooler. Another option is to convert a combined drum dryer and cooler into a single drum dryer, then add a Solex cooling unit. This retrofit allows for increased sugar production capacity, as well as a higher quality of finished sugar.



Conclusion

As a significant contributor to the economic welfare of many countries globally, the inefficient use of energy in traditional sugar processing cannot be overlooked. The need to reduce operating costs and improve energy efficiency are the driving evolution and growth within the sugar processing industry with new technologies such as Solex heat exchangers.

Learn more about the Solex heat exchanger and sugar cooling. Read case studies on the Solex heat exchanger in sugar processing facilities.