Exploring the Sucrose-Water State Diagram

The sucrose-water state diagram is a useful map for understanding and predicting the behavior of sucrose.

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At first glance, sugar-water state diagrams can appear rather complex and far from being a practical tool for understanding and improving confectionery products. However, over the last several years, these diagrams have been instrumental in building a bridge between the art and the science of candymaking. The purpose of this article is to illustrate the usefulness of the sucrose-water state diagram as a map for understanding and predicting the behavior of sucrose alone and in sucrose-containing systems. We will journey around the sucrose-water state diagram exploring processes, such as hard candy cooking, stopping at specific points of interest, such as the melting temperature of sucrose, and examining differences in water-solid interactions between crystalline and amorphous states.

SUCROSE-WATER STATE DIAGRAM

In its simplest form, the two-dimensional sucrose-water state diagram[1] is composed of four main curves (Figure 1): the equilibrium freezing (or melting) curve, the equilibrium vaporization (or boiling) curve, the equilibrium saturation solubility curve and the glass transition curve. The equilibrium freezing and vaporization curves are also known as the freezing point depression and boiling-point elevation curves, respectively. This two-dimensional plot shows the physical state of sucrose as a function of temperature and sucrose concentration. The two other possible state diagram dimensions, pressure and time, are often excluded from the diagram, assuming that pressure is constant and omitting time-dependence aspects. Sucrose concentration can be plotted as the dissolved, solution or liquid-phase concentration (g dissolved sucrose/100 g solution) or the total amount of sucrose present (g dissolved and g crystalline sucrose/100 g total). Most often, and most appropriately, the

Sucrose-water State Diagram

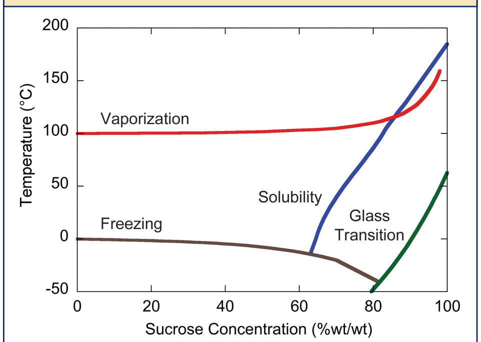

Figure 1

[1] The term *state diagram* is used herein, since, strictly speaking, a state diagram includes both equilibrium (e.g., freezing, vaporization and solubility) and nonequilibrium (e.g., the glass transition) events in a single figure; whereas, a phase diagram should contain only equilibrium events. The term *supplemental phase diagram* is also used.

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