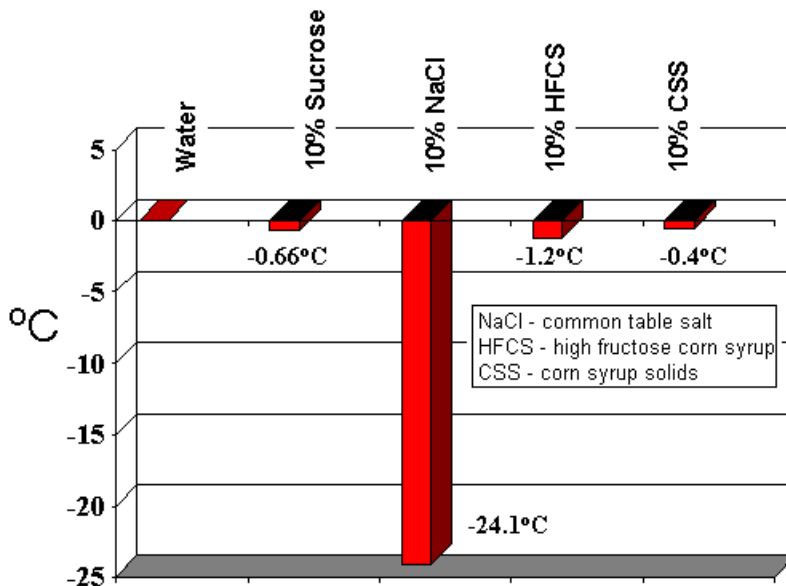


Formulating for a Particular Ice Content

Formulating for a particular ice content using TechWizard™ can be useful for a variety of frozen products. For example, the ice content of a frozen dessert imparts much of the mouthfeel to the product. If the ice content at serving temperature is outside an acceptable range then the frozen dessert will most likely also be unacceptable. The ice content of a product at a particular temperature is dependent on its freezing point and the freezing point is dependent on what is in the product. Water-soluble components can reduce the freezing point (make the product freeze at a lower temperature). The smaller the molecular weight of the component the more effective it is at reducing the freezing point (see figure below).

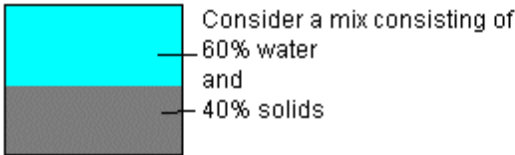
Freezing Point Differences



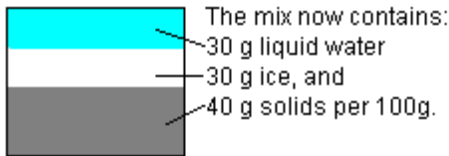
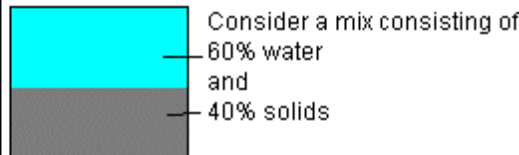
Experiments have been done to determine the reduction in freezing point for a given concentration of sucrose. With this information we can determine, for a given component in solution, the equivalent concentration of sucrose that would have the same freezing point (sucrose equivalents). When components in a product are converted to an equivalent concentration of sucrose, we can determine the freezing point from the sucrose data. This information is used to calculate the ice content at a particular temperature. **For example two ice cream formulas can have the same ice content if they have the same water content or total solids, the same MSNF (which contributes milk salts and lactose); and the same sucrose equivalents. Hence, these properties (MSNF, total solids, sucrose equiv.) should be included in the formula development stage if you are trying to match ice content.**

Percent Water Frozen or Percent Product Frozen

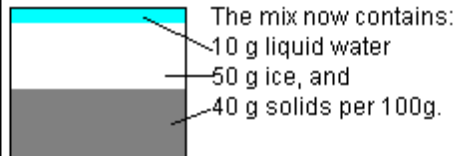
The freezing characteristics of a product can be determined based on % water frozen or % product frozen. The % water frozen term is the more common term used in relation to frozen desserts. The term can be explained by the following example. If a liquid mix contains 40% total solids then the rest of the mix is water, i.e., the water content is 60%. If 50% of the water in the mix is frozen (50 % water frozen) then half of the 60% water is frozen or the mix contains 30 g of ice for 100 g of product. This leads us to the other term used to express freezing characteristics, % product frozen. The % product frozen is simply the grams of ice per 100 grams of product. A value of 50% product frozen means that the mix contains 50 grams of ice per 100 grams of product.

Explanation of % Water Frozen


If 50% of the water is frozen
then we have the following:


**Explanation of % Product Frozen
(g ice / 100 g product)**


If 50% of the product is frozen (50g ice/100g
product) then we have the following:



Typical Composition and Freezing Characteristics of Frozen Desserts

Evaluation of the freezing characteristics of frozen desserts is a developing science. The multitude of interactions between the many ingredients that go together to make frozen desserts makes it difficult to set hard and fast rules on what the ice content or freezing point of a frozen dessert should be. The user should use this information to help develop quality parameters that work best for the particular product. In this way, the user can develop their own quality standards for what the freezing characteristics of a particular product should be for it to have the best consumer acceptance and the best shelf life. The following composition and freezing data are provided as a reference. You may wish to compare results for your formulations with these values.

Frozen Dessert - Composition

Dessert Type	Fat (%)	MSNF (%)	Sugar (%)	Corn Syrup Solids (%)	Stab/ Emuls (%)	Sucrose Equiv. (g/100g)	Total Solids (%)	Lactose (%)	Rel. Sweetness (g/100g)	Overrun (%)
Soft-Serve Ice Cream	3.0	14.0	10.0	4.0	0.5	20.3	31.5	7.4	13.0	30 - 50
Soft-Serve Ice Cream	6.0	12.5	12.0	4.0	0.4	21.5	34.9	6.6	14.9	30 - 50
Soft-Serve Ice Cream	10.0	11.0	12.0	3.0	0.4	20.0	36.4	5.8	14.3	30 - 50
Hard-Pack Ice Cream	10.0	11.5	15.0	0	0.3	21.1	36.8	6.1	16.0	75 - 90
Hard-Pack Ice Cream	14.0	10.0	15.0	0	0.3	20.3	39.3	5.3	15.8	60 - 75
Sherbet	2.0	1.9	14.00	9.7	0.4	21.6	32.5	1.0	18.1	30 - 40
Ice	0	0	23.00	7.0	0.3	28.1	32.7	0.0	26.2	25 - 30
Milk Shake	4.0	12.5	13.0	5.0	0.4	23.3	34.9	6.6	16.3	10 - 15
Malted Milk	6.0	12.0	10.5	4.5	0.2	20.1	36.0	6.4	13.5	10 - 15

Source: *Ice Cream*. R. T. Marshal and W. S. Arbuckle. 1996. Chapman and Hall, NY.

Frozen Dessert - Calculated Freezing Characteristics

Dessert Type	Fat (%)	Freezing Point (°F)	Freezer Exit Temp. (°F)	% Water Frozen	g ice / 100 g product
Soft-Serve Ice Cream	3.0	27.9	20 (18 - 20)	63.0	43.1
Soft-Serve Ice Cream	6.0	27.5	20 (18 - 20)	59.8	39.0
Soft-Serve Ice Cream	10.0	27.8	20 (18 - 20)	62.1	39.5
Hard-Pack Ice Cream	10.0	27.5	20 (19 - 25)	59.8	37.8
Hard-Pack Ice Cream	14.0	27.6	20 (19 - 25)	60.3	36.6
Sherbet	2.0	28.3	21	63.4	42.8
Ice	0.0	27.3	21	53.5	36.0
Milk Shake	4.0	27.2	26	18.8	12.2
Malted Milk	6.0	27.7	26	27.5	17.6

Frozen Dessert - Calculated Freezing Characteristics (continued)

Dessert Type	Fat (%)	Serving Temp. (°F)	% Water Frozen	g ice / 100 g product	Freeze - Thaw During Storage (0 to 10 °F)	
					% Water Frozen	g ice / 100 g product
Soft-Serve Ice Cream	3.0	22 (18 - 22)	56.3	38.5	5.9	4.0
Soft-Serve Ice Cream	6.0	22 (18 - 22)	52.6	34.3	6.3	4.1
Soft-Serve Ice Cream	10.0	22 (18 - 22)	55.3	35.2	6.0	3.8
Hard-Pack Ice Cream	10.0	10	76.3	48.2	6.3	4.0
Hard-Pack Ice Cream	14.0	10	76.6	46.5	6.2	3.8
Sherbet	2.0	10	79.6	53.8	5.3	3.6
Ice	0.0	21 (19 - 21)	53.5	36.0	6.6	4.5
Milk Shake	4.0	26 (26 - 28)	18.8	12.2	6.8	4.4
Malted Milk	6.0	26 (26 - 28)	27.5	17.6	6.0	3.9