ICE-CREAM & FROZEN DESSERTS

Module 5. Thermodynamics of freezing and refrigeration load

Lesson 14
TYPICAL FREEZING CURVE. CALCULATING FREEZING POINT OF ICE CREAM MIX

14.1 Introduction

The freezing behavior of pure water and a solution made up of various solutes (similar to ice cream mix) are different. The same is depicted in **Fig.14.1**.

Where:

A= Temperature of aged ice cream mix

B= Super cooling of ice cream mix in the freezer

C= Actual freezing point of ice cream mix

D= Lowering of freezing point of ice cream mix

E= Eutectic point at which salts starts to crystallize out along with conversion of water in to ice crystals

F= Eutectic point of another salt in the ice cream mix

G= Further freezing of water in ice cream mix

14.2 Basic Concepts Related to Freezing Point of Ice Cream Mix

Freezing point (FP) of ice cream mix varies appreciably with composition.

The mix constituents that affect FP directly are:

- Sugar
- Lactose
- Milk salts
- Any other substances that may have been added and that are in true solution.

Other mix constituents affect FP indirectly by replacing water. For instance, if fat or milk protein or any other constituent, not in true solution, is increased,there is less water in the mix and the resulting higher in-water concentration of truly soluble substances causes a lowering in FP.

Osmometer is used to determine FP of mix. It reads in milli-osmols/kg H_2O.

Where FP(^oC) = mOsm/kg of water x –0.001858

14.2.1 Calculating/Determining the FP of ice cream mix

Where A =parts of sucrose + lactose/100 parts of water

B = Lowering in FP due to milk salts

$$A = \frac{(\%\ \text{Serum Solids} \times 0.545 + \%\ \text{Sucrose})}{\%\ \text{of Water in the mix}} \times 100$$

From the graph of FP lowering (°C) vs. parts of sugar/100 parts of water, find the FP lowering based on the concentration of sugar.

$$B = \frac{\%\ \text{Serum Solids} \times 2.37}{\%\ \text{of Water in the mix}}$$

FP of mix (°C)= - (A + B)

An average mix containing 12.0% fat, 11.0% MSNF, 15% sugar, 0.3% stabilizer has a FP of about -2.5°C. The FP of mixes with high sugar and MSNF content may be about -3.06°C, while for mixes with high fat, low SNF or low sugar content may be about -1.39°C.

14.2.2. Means to save energy in freezing and cold storage

About 15-30% of the energy can be saved by optimizing the plant performance, better maintenance or replacing the key components. The control of the systems can be used to identify the optimum time to load shed,defrost, and to run compressor to maintain correct temperature whilst minimizing energy usage. Any reduction in the refrigeration system condensing temperature or rise in the evaporating temperature will enable saving energy.Switching off the refrigeration system during peak demand energy periods is advisable.

Unloading the ice cream from the freezer at a faster pace and immediately transferring the packaged products into the hardening room helps in saving energy. In the cold stores, control

of evaporator fans, refrigeration system or temperature inside the cold room can help in saving energy used for refrigeration.

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