13.2 Boiling Point Elevation – Maple Syrup

**Subjects:** Solutions, Boiling point elevation, colligative properties

**Description:** Demonstrate that maple syrup has a higher boiling point than water. As maple syrup continues to boil, the solution becomes more and more concentrated as water is lost. The increasing concentration of sugar in the water increases the boiling point of the solution.

**Materials:**
- 100g grade A maple syrup (or 67% w/w sugar solution)
- 400 ml beaker
- Stir bar
- Hot plate*
- Thermometer

*Shared item: located in the top drawer of the center bench opposite the chemical storage shelves.
Provided by instructor

**Procedure:**
1. Heat the syrup in the beaker until boiling. Record the temperature.
2. Continue to stir and boil syrup.
3. Measure the temperature again over time. The temperature will increase as the water evaporates.

**Discussion:**
Maple sap has approximately 2% sugar. To produce maple syrup, the sap is boiled until enough water has evaporated to produce a syrup with approximately 67% sugar content with a boiling point of 219 degrees Fahrenheit (103.8˚ C)\(^1\)\(^2\).

Maple sap contains other solutes besides sugar, but assuming these concentrations are negligible, we can calculate the boiling point elevation of maple syrup compared with water.

Elevation in boiling point = \(\Delta T_{bp} = K_{bp} \cdot m_{solute}\)

Maple sugar is primarily sucrose \((C_{12}H_{22}O_{11})\) with a molecular weight of 342.30g/mol.

Assume we have 100 grams of Grade A light maple syrup containing 67% sugar. The solution is composed of 67 grams sucrose and 33 grams water. The \(K_{bp}\) for water is 0.5121˚C /m.

Moles of sucrose = 67g \((1 \text{ mol/ } 342.30 \text{ g}) = 0.1957 \text{ mol sucrose}\)
Molality \((c_{\text{sucrose}})\) = 0.1957 mol/0.033 kg water = 5.93 m

Elevation of BP = \(K_{\text{bp}} \times m_{\text{sucrose}} = (0.5121 \, \text{°C/m})(5.93 \, \text{m}) = 3.03 \, \text{°C}\)

Boiling point of maple syrup is 100.0 + 3.03 = 103.03°C

The boiling point stated above (taken from the producer’s websites) is 0.77 °C higher than what we calculated. Ask the students to answer this question. Is this because, in reality, syrup also contains a small amount of other solutes that contribute to the increase in boiling point?

After boiling for some time we lose approximately 5 grams of water. There are still 67 grams of sucrose in the solution. What is the boiling point now?
Molality \((c_{\text{sucrose}})\) = 0.19 mol/ 0.028 kg water = 6.99 m

Elevation of BP = \(K_{\text{bp}} \times m_{\text{sucrose}} = (0.5121 \, \text{°C/m})(6.99 \, \text{m}) = 3.57 \, \text{°C}\)

Boiling point of maple syrup is 100.0 + 3.57 = 103.57°C

What is the percentage of maple sugar in the syrup now?

\[
\frac{67 \, \text{g}}{67 \, \text{g} + 28 \, \text{g}} \times 100 = 70\%
\]

**Safety:** Use caution working with boiling materials to avoid burns.

**Disposal:** Syrup can be washed down the drain

**References:**