Learning Objectives

• Describe how solutes affect the properties of solvents in solutions.
• Give examples of freezing point depression and boiling point elevation.

Why hasn’t the ocean water in this photo turned to ice? The water in the glacier on shore is frozen solid, but the water in the ocean is still in a liquid state.

Q: What is it about ocean water that keeps it from freezing when the temperature falls below the freezing point of pure water?
A: Ocean water is salty.

How Solutes Affect Solvents

Salt water in the ocean is a solution. In a solution, one substance, called the solute, dissolves in another substance, called the solvent. In ocean water, salt is the solute and water is the solvent. When a solute dissolves in a solvent, it changes the physical properties of the solvent. In particular, the solute generally lowers the freezing point of the solvent, which is called freezing point depression, and raises the boiling point of the solvent, which is called boiling point elevation. For example, adding either salt to water lowers the freezing point and raises the boiling point of the water.

Freezing Point Depression

Pure water freezes at 0 °C, but the salt water in the ocean freezes at -2.2 °C because of freezing point depression. We take advantage of the freezing point depression of salt in water by putting salt on ice to melt it. That’s why the truck in the Figure 1.1 is spreading salt on an icy road.
Did you ever see anyone add a fluid to their car radiator? The fluid might be antifreeze, like in the Figure 1.2. Antifreeze lowers the temperature of the water in the car radiator so it won’t freeze, even when the temperature falls far below 0 °C. For example, a 50 percent antifreeze solution won’t freeze unless the temperature goes below -37 °C.
Boiling Point Elevation

Antifreeze could also be called “antiboil” because it also raises the boiling point of the water in a car radiator. Hot weather combined with a hot engine can easily raise the temperature of the water in the radiator above 100 °C, which is the boiling point of pure water. If the water boils, it could cause the engine to overheat and become seriously damaged. However, if antifreeze has been added to the water, the boiling point is much higher. For example a 50 percent antifreeze solution has a boiling point of 129 °C. Unless the water gets hotter than this, it won’t boil and ruin the engine.

MEDIA

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Summary

- When a solute dissolves in a solvent, it changes the physical properties of the solvent.
- A solute generally lowers the freezing point of a solvent, which is called freezing point depression. For example, spreading salt on an icy road melts the ice.
- A solute generally raises the boiling point of a solvent, which is called boiling point elevation. For example, adding antifreeze to the water in a car radiator prevents the water from boiling.

Review

1. What is freezing point depression?
2. Give an example of boiling point elevation.
3. Assume you are going to boil water to cook spaghetti. If you add salt to the water, how will this affect the temperature at which the water boils? How might it affect the time it takes the spaghetti to cook?

References

1. Michael Pereckas. This truck is spreading salt to unfreeze the roads . CC BY 2.0
2. Flickr:EvelynGiggles. Antifreeze lowers the freezing temperature of the water in car radiators . CC BY 2.0