

How to Freeze Soda Instantly!

We have previously examined the effect of dissolved carbon dioxide on fizzy drinks. You may have seen the cola/lemonade-Mentos experiment whereby addition of Mentos to cola/lemonade causes the dissolved carbon dioxide to fall out of solution causing a huge pressure rise in the bottle which results in a spectacular cola/lemonade shower¹.

In this article we will examine the effect of carbon dioxide as an impurity on the freezing point of soda.

The melting point/freezing point of a liquid is affected by its purity. Impurities will lower freezing points, because atoms/ions/molecules of impurity can get in the way of the formation of the crystal lattice of the solid. This is why we add salt to ice on our paths. Antifreeze (a mixture of ethylene glycol (ethan-1,2-diol and corrosion inhibitors)) is also added to the coolant in the engine of cars. The reason for this that a volume of ice occupies more space than the equivalent liquid water; since the coolant system of an engine is sealed the expansion of the ice can crack an engine block.

MATERIALS

You will need:

- Thermometer
- Salt
- Ice Cubes
- Pudding basin
- 500ml bottles of cola or lemonade.

HEALTH & SAFETY

There are no particular health & safety issues with this experiment.

METHOD

Using the ice cubes and pudding basin make a slush by crushing the ice cubes, adding salt then adding some water. The addition of the salt to the ice causes its freezing point to lower, and this 'cost' the ice energy to melt (the latent heat of fusion) and the temperature drops to a potential -18°C .

Before the advent of freezers, ice cream was made by mixing ingredients in an ice/salt bath in the same way. Allow the temperature to reach about -3 to -5°C and place the bottles of soda into the bath. They should be allowed to cool to the point just before ice begins to form inside.

When the bottles are at the correct temperature take one out and unscrew the tap. There should be a hiss of escaping gas then if the conditions are correct ice will begin to form spontaneously until the whole mass of liquid turns to solid.

EXPLANATION

The carbon dioxide inside the soda is effectively an impurity; therefore the freezing point of the liquid is depressed. When the pressure inside the bottle is lowered by the cap being unscrewed, some of the carbon dioxide escapes so there is effectively less impurity in the soda. The freezing point therefore rises and, if the conditions are correct the soda freezes spontaneously.

The process is also helped along by the same process which causes the cola/lemonade-Mentos fountain, that of nucleation. The bubbles of carbon dioxide 'seed' the formation of ice crystals, and as soon as ice crystals form, they cause the formation of others which causes a wave of freezing throughout the body of the liquid.



¹ Science at Home – The Lemonade and Mentos Fountain