

# The bubbly chemistry behind carbonated beverages

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Many people love the refreshing effervescence of a soda, champagne, beer or sparkling water. When you take a sip, the gas bubbles in the beverage burst, and the [released gas](#) tickles your nose. But have you ever wondered how carbonation actually works?

I'm a [professor who teaches classes in chemistry and fermentation](#) and a carbonated beverage enthusiast and home brewer myself. While the basic process of carbonation is relatively simple, a variety of factors—from temperature to surface tension—can affect the taste and quality of beverages.

## Dissolving carbon dioxide

Carbonation involves dissolving the colorless and odorless [carbon dioxide](#)—CO<sub>2</sub>—gas into a liquid. When [carbon dioxide](#) is added to a sealed [bottle](#) or can containing water, the pressure in the bottle or can increases, and the [carbon dioxide dissolves](#) into the liquid.

The CO<sub>2</sub> above the liquid and the CO<sub>2</sub> dissolved in the liquid [reach chemical equilibrium](#). Chemical equilibrium essentially means the rate that CO<sub>2</sub> dissolves into the liquid is equal to the rate that CO<sub>2</sub> is released from the liquid. It's based on the amounts of CO<sub>2</sub> both in the air and in the liquid.

Some of the dissolved CO<sub>2</sub> reacts with the water to form carbonic acid, which has a chemical formula of H<sub>2</sub>CO<sub>3</sub>. So once some of the dissolved CO<sub>2</sub> converts to H<sub>2</sub>CO<sub>3</sub>, more CO<sub>2</sub> from the air above can dissolve into the liquid and reestablish [chemical equilibrium](#).

When you open a bottle or can, the pressure above the carbonated liquid drops to match the pressure outside of the bottle or can. The pressure release results in a hissing sound, and you see bubbles rising in the liquid as the H<sub>2</sub>CO<sub>3</sub> converts back to CO<sub>2</sub> and that gas [escapes to the surface](#). The [carbonic acid](#) in the beverage is what makes it [taste a little sour](#).

## A colder drink is a bubblier one

Another important factor influencing carbonation is temperature. Most gases, including carbon dioxide, do not dissolve well in liquids as the [temperature of the liquid rises](#). That's why [carbonated drinks go flat](#) if you leave them out at room temperature.

Conversely, if you place your favorite carbonated beverage in the refrigerator and allow it to get cold, more dissolved carbon dioxide will stay in the beverage while it's still sealed. When you open the chilled bottle or can, the [liquid is more bubbly](#) because there was more dissolved carbon dioxide in the cold beverage.

## Surface tension and fizziness

One final important factor for carbonation is the surface tension of the liquid. A liquid's surface tension is determined by how strongly the liquid's [molecules interact with each other](#). For most beverages, those molecules are [water molecules](#), but diet soft drinks have [artificial sweeteners](#) dissolved in them. These sweeteners can weaken the interactions between the water molecules, creating a lower surface tension. A lower surface tension means the carbon dioxide bubbles [form faster and last longer](#).

This is why it takes slightly longer to be served a Diet Coke on ice, a problem you might notice on a plane. The lower [surface](#) tension from the artificial sweetener means there's more fizz, and for longer, compared with other soft drinks. The [flight attendants](#) then have to [wait for the bubbles in the cup to break](#) before they can fill the cup with more Diet Coke.

Surface tension is also why Diet Coke works so well in the [famous Mentos experiment](#), during which you drop Mentos candies into 2-liter Diet Coke bottles. The candy helps to weaken the interactions between the water molecules and the CO<sub>2</sub> molecules, lowering the [surface tension](#)

and allowing for an easier release of  $\text{CO}_2$  molecules. A bubbling "geyser" of Diet Coke rises fast above the 2-liter bottle as the  $\text{CO}_2$  molecules quickly form on the candy's surfaces and force the Diet Coke out of the bottle.

## Getting the bubbles into a beverage

In an effort to make water similar to that from mineral springs, the carbonation process was invented by Joseph Priestley in England in the 1760s and commercialized by Jacob Schweppe—recognize the name?—[in Switzerland in the 1780s](#). Priestley reacted chalk with sulfuric acid, producing  $\text{CO}_2$ , and he hung a water-filled container over the reaction to [infuse the water with  \$\text{CO}\_2\$](#) .

Today, most commercial beers, [soft drinks](#), seltzers and sparkling waters are created by "forced" carbonation. This is when manufacturers directly inject carbon dioxide into the beverage [under high carbon dioxide pressures](#).

A second common way to introduce carbon dioxide into a liquid is by [fermentation](#). Champagne manufacturers and some small [home beer brewers](#) follow this method by sealing a sugar source and live yeast into their bottles. The yeast produce alcohol and carbon dioxide, and this carbon [dioxide](#) increases the pressure in the bottle, resulting in [carbonated champagne and beer](#). But this process is not as controlled and can result in [exploding bottles](#).

Larger brewers often capture  $\text{CO}_2$  produced during a fermentation process and pump that gas into the tanks that contain beer to carbonate the beer. This is normally a controlled process that allows for [known amounts of carbon dioxide](#) to be introduced into the beverages for outstanding consistency.

Carbonation is a marriage between physics and chemistry—one that transforms ordinary liquids into effervescent treats. The next time you drink a carbonated beverage, take a moment to appreciate the science behind those dancing bubbles.

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