

The chemistry behind a common annoyance

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Those of you living in municipalities with hard water or who have wells with hard water may have noticed annoying white bits floating on top of the water in your kettle. It is particularly noticeable when you make tea since the dark liquid provides a contrasting background. So, what are these tiny particles and how did they get there?

The short answer to the first part of this question is that they are small pieces of limestone, or more properly, calcium carbonate. However, why are they a problem in kettles and not in water bottles where the same water is used?

If you look at the base of your kettle, you may see deposits on the heating coils or heating surfaces that have built up over time. These deposits reduce heat transfer efficiencies and can be quite problematic in industrial food processing. Such deposits form on the hottest surfaces first. Once the bulk of the water gets hot enough, they begin to form in the liquid as small particles.

The small particles of calcium carbonate are so prevalent in some cases that they can clog the screens on the spouts of kettles. I've mentioned in a previous article that you can get rid of the deposits in your kettle by using vinegar to dissolve them, and then rinsing the kettle thoroughly afterwards. In industry, various other acidic solutions are used.

Now let's look at the chemistry behind what's happening. When rain falls through the air, it absorbs carbon dioxide which then creates a weak acid solution. Don't get this confused with "acid rain" – that's another thing altogether. As the mildly acidic rainwater travels into the soil and downwards through the underlying rock, it dissolves minerals which include calcium carbonate. As a result, calcium bicarbonate is formed.

When water containing the dissolved calcium bicarbonate is heated, carbon dioxide gas is driven off as the sodium bicarbonate breaks apart. This reduces the acidity and converts the calcium bicarbonate to calcium carbonate which is not as soluble as its bicarbonate form. As a result, the calcium carbonate starts coming out of solution. It first does this around the heating elements which are the source of the heat and clings to their surfaces. With increased heating of the water, more and more calcium carbonate comes out of solution throughout the water. When there is nothing for the calcium carbonate to collect upon, it clusters together in small particles.

The fine mesh filters on some kettles are designed to remove these particles. However, once they get clogged up, they create a problem in pouring the boiling hot water. The remedy for this is quite simple – just remove the filter from the kettle and soak it for a

while in vinegar, as already mentioned. That will re-solubilize the calcium carbonate and remove it.

If you have soft water, you probably will not notice this problem. However, if you use a water softener, you may want to check about the sodium levels in your water since there can be some potential health impacts from the sodium.



Screen from a small kettle plugged with calcium carbonate particles.