



Q & A: Boiling and Freezing points of pure and salty water

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Q:

What is the boiling and freezing point of both fresh and saltwater?
- maria (age 13)
congress middle, lake worth , F.L., Florida

A:

Hi Maria,

For pure water, the boiling point is 100 degrees Celsius (212 Fahrenheit) at one atmosphere of pressure, and the melting point is 0 degrees Celsius (32 degrees Fahrenheit) at one atmosphere of pressure. At lower pressures (at high altitudes, for example, in Denver, Colorado), the boiling point will be perhaps a couple of degrees lower.

For saltwater, the boiling point is raised, and the melting point is lowered. By how much depends on how much salt there is. I'll assume the salt is sodium chloride, NaCl (table salt). The melting point is lowered by 1.85 degrees Celsius if 29.2 grams of salt are dissolved in each Kg of water (called a "0.5 molal solution" of salt. The Na and Cl dissociate right away when dissolved, and so for a 0.5 molal solution of salt, there is a 1.0 molal concentration of ions). The boiling point is raised by 0.5 degrees Celsius for water with 29.2 grams of salt dissolved in each kg of water.

If your concentrations of salt are different, then you can scale the boiling point elevation and melting point depression predictions directly with the concentration.

These numbers come from the CRC Handbook of Chemistry and Physics.

Tom

(published on 10/22/2007)

Follow-Up #1: pressure and freezing

Q:

Increasing pressure on water raises its boiling point does it raise its freezing point
- Gary
muswellbrook nsw australia

A:

Raising pressure actually lowers water's freezing point a little. That's because ice occupies more volume than liquid water, so squeezing tends to drive it to become liquid.

That's rather unusual for freezing points, since the solid occupies less space than the liquid for most substances.

Mike W.

(published on 10/22/2007)

Follow-Up #2: efficiently salting water

Q:

So, following the conclusion that salt water has a higher boiling point than fresh water, comes the question; From a perspective of energy consumption, when to add salt to the water when boiling spaghetti ? I.e.; if I add the salt to the water while its still cold, it takes more energy to make it boil ? If I add it when the water boils at 100 C, the water stops boiling, and needs to consume more energy to come up to the new boiling point ? At the end, same energy is required to make a portion of spaghetti I'd assume ? :-)
- jacob hansen (age 39)
Naestved, denmark

A:

You're basically right. Either way you start out with plain water and salt at room temperature. The noodles go in when you have salty water at its boiling point. The energy difference between that and the starting point doesn't depend on when you add the salt.

A little energy is lost to evaporation on the way, however. If you wait until the water is boiling, then add salt, then boil again, the water is spending a little more time near boiling than it would if you add the salt first. So you lose a little more energy. It's marginally more efficient to add the salt first.

Mike W.

(published on 06/18/2009)

Follow-Up #3: salt water boiling

Q:

approx how much minnimum salt (in grams) needs to be added to one litre of kitchen tap water to make the boiling temperature increase above 100 degree Celcius? ***** i'm desperate for an answer, cuz it's for an assignment if u cant give an answer, do u have any idea of some useful websites that can help me? sincerely anonymous
- anonymous
australia

A:

I've marked your question as a follow-up to one that already had an answer. Any amount of salt will raise the boiling point above 100°C. The question is how much above that you wish to get. The answer above should help with that.

Mike W.

(published on 04/21/2011)

Follow-Up #4: salt nucleating steam

Q:

I am confused now. Whenever I boil water for pasta I add the salt when I get impatient waiting for it to boil. When I add the salt when it is near boiling it instantly will boil. This is the exact opposite of then physics being described here. Is this due to another phunomina? Does the salt provide a point for the steam to nuecleate on?
- Luke (age 30)
Boston

A:

Exactly, you guessed it.

Mike W.

(published on 01/17/2012)

Follow-Up #5: Using salt in humidifiers

Q:

I'm sick and I'm trying to get my humidifier to put as much water in the air as possible. This is one of the cheap humidifiers that boils the water and makes steam. I think I read in the directions that if you add a pinch of salt it put more water in the air. How would that work? I mean, that would raise the boiling point, so maybe the water gets hotter, like 103 degrees celsius - but seems like it would just take longer to boil. Once it hits 103 why would more steam come out than at 100?
- John (age 45)
Overland Park KS, USA

A:

I use that sort of humidifier. Adding salt does work. The heating comes from the electrical current flowing through the water. Tap water has a pretty low conductivity, so not much current flows. Adding salt raises the conductivity, since the ions are electrically charged. You actually have to be a bit careful not to add too much salt, since you don't want to blow a fuse.

The effects on the boiling point are very minor compared to the effects on the conductivity.

BTW, although these humidifiers are cheap they do have the nice advantage that since they output water vapor, not dorps, you don's have to worry about bacteria ect. getting spraued into the air.

Mike W.

(published on 02/24/2014)

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