

The Importance of Ice Density -Aldo Bonincontro

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As we all know, ice is less dense than liquid water (0.917 g/cc) with an increase of its volume of about 8% and this minor density of the solid phase respect to the liquid one is very rare among chemical compounds. This fact is fundamental for the life and the same geology and landscape of our planet.

Ice is less dense mainly because of the high polarity of H₂O molecule, due to a partial negative charge on the O (more electronegative and, hence, stronger in attracting the electrons of the molecule) and partial positive charges on the H atoms. This obliges the molecules at the crystalline state of ice to fix their position in a less dense structure than in the liquid phase, when the partially chaotic movement of molecules allows them to stay a little closer.

Let's try to imagine what could be our planet if the ice were denser; polar ice would sink to the bottom of the sea immediately after its formation at the contact with the cold of the atmosphere; the ice on the bottom would have accumulated on the sea bottom, protected by the overlying liquid water and eventually, all the water would be frozen also on the surface. In this way, wide volumes of the sea would be replaced by sedimentary ice on the poles and in the lakes of northern regions. Penguins, fish, whales and seals couldn't swim under the frozen surface of the sea and they would live on the emerged masses of ice and also submarines couldn't cross the Arctic ocean navigating below the ice pack and there wouldn't be floating icebergs (this would be positive for navigation!).

Moreover, we humans couldn't skate anymore on the ice along rivers and lakes when these are too deep and water doesn't freeze also at the surface, after the sinking of the ice formed from most water. Our cocktails "on the rocks" would have the ice only on the bottom of the glass and so on.

An hypothetic higher density of ice would go together with a decrease of its volume; this would have its positive effects because our bottles full of water wouldn't crack as it happens in the reality if placed in the freezer and, above all, the water in pipes exposed to cold wouldn't make explode anymore them or the valves during cold winters.

This increased volume of ice caused by its lower density is responsible of the further erosion of rocks during cold winters in the mountain or in polar regions because the water present in the cracks inside the rocks enlarges them with freezing and causes new cracks, easing a faster demolition of the rocks.

The minor density of ice, in any case, is useful in our real world to obtain pure water or concentrated salt from salty water of the sea in cold regions where its condensation under the Sun is too slow or impossible for part of the year. The superficial crust of ice can be removed but it can still contain inclusions of salty water and it needs further crushing and washing treatment when performed in industrial plants. For this reason, in many cases, it's better to evaporate water with heat and low pressure and condensate its vapours (distillation).