

# Water & Ice

## Some Interesting Facts

By Norm Christopherson

Those of us in the heating and cooling industry know that our business allows us to consider many aspects of the liquids, gases and solids around us. This is especially true when we heat, cool and cause them to change physical states.

The ice machine uses the changes in state of a refrigerant to cause water to change state and produce ice. So, an ice machine is a device that uses the change of state of one substance to cause another substance to change its state. Water is the raw material and ice is the product. So, here are some interesting facts about water and ice.

Water is a most remarkable substance even though we often perceive it as ordinary. We wash in it, swim in it, drink it, make ice from it, skate on it and cook in it, although not all at the same time. Almost 75% of the Earth is covered with water and about 70% of the human body consists of water. Most of our food is water; mushrooms are 98% water, tomatoes are 95% water, milk is 90% water, potatoes are 80% water and beef is 61% water. More than half of the world's animal and plant life live in the water. There is water in the Earth's atmosphere, on the Earth's surface and under the ground. Approximately 75% of all the Earth's fresh water is contained in glaciers which are 100% fresh water and the ice thickness at the poles is as much as 10,000 feet thick. As common as water is it actually acts in some very uncommon ways.

Water is unique in that it is the only natural substance that exists in all three states, solid, liquid and gas at the temperatures normally found on Earth. And, under certain conditions water can exist in all three states (Called the "triple point") at the same time. The unit of heat quantity, the BTU is based upon how much heat it takes to change the temperature of one pound of water by one degree F. The specific heat of water is the basis of comparison for the specific heats of all other substances. We even rate the cooling capacity of air conditioning and refrigeration equipment on the cooling rate capacity of a ton of melting ice.

Water has one of the highest heat capacities of all substances. In fact, a 1-inch diameter pipe carrying heated or cooled water is capable of transporting heat at the same rate as a 10 by 18 inch duct in a forced air system.

When water is cooled the speed of its' molecules slow down and it becomes more dense just as with all other substances. As the temperature drops molecules gather closer together increasing the density. Water reaches its greatest density at 4 degrees C or 39 degrees F. However, when water freezes something quite strange happens. As the water

freezes its density reverses and the water expands. The density of ice is less than that of liquid water and this is why ice floats on water. This accounts for the fact that ice freezes and remains at the top of bodies of water and why lakes do not freeze from the bottom up. The power of freezing ice expanding is incredible. No container can be constructed that can withstand the power of expansion when water inside the container expands upon freezing.

Water has one of the highest latent heat values of all liquids making it an ideal substance for use in evaporative coolers and cooling towers. And, it is non-toxic, relatively inexpensive and recyclable.

The surface tension of water is amazing. A metal needle can float on water due to the surface tension or skin water builds up at its surface. This also allows some insects to actually “walk on water”. This same surface tension is called capillary action that allows water to climb up a drinking straw to a level above the surface of the water in the container the straw is placed. The smaller the diameter the hollow straw, the higher the water climbs. Any crack, crevice or small space will attract and hold water due to this capillary action or surface tension. This is exactly how molecular sieve driers attract and hold moisture in a refrigeration system. The desiccant is a material containing many small tubes, crevices and tiny pockets that attract and hold water molecules. The capillary action or surface tension of water also causes water in a mechanical refrigeration system to become attracted to the cracks, crevices and tiny spaces in a compressor or around joints in tubing. This attraction is so great that it requires an evacuation as low as 500 microns to break the moisture’s surface tension in order to vaporize the moisture during an evacuation. Even then not all the moisture may be removed which is why we install a filter-drier containing a desiccant.

Pure water is also an insulator to electrical current, that is, it has a high dielectric strength. It only becomes an electrical conductor when minerals or salts are dissolved in the water. And, speaking of that, water is the universal solvent. Almost every other substance has been found dissolved in water. Water has a neutral Ph and is neither an acid nor a base.

If you ask most people, which is heavier, dry air or water vapor, they will answer, water vapor. This is obviously incorrect when you consider the fact that clouds (A collection of water vapor) are high in the sky. If water vapor were denser than dry air we would all be constantly in the fog, which would account for some of our foggy thinking. Actually, a solid understanding of water vapor is important to an understanding of the study of psychrometrics.

Water and ice have many other physical, chemical and thermal qualities that make it unique from all other substances. So the next time you are drinking a glass of water, measuring relative humidity, repairing an ice machine, evacuating a system or installing a filter-drier, think about the qualities and value of water, a most amazing substance.