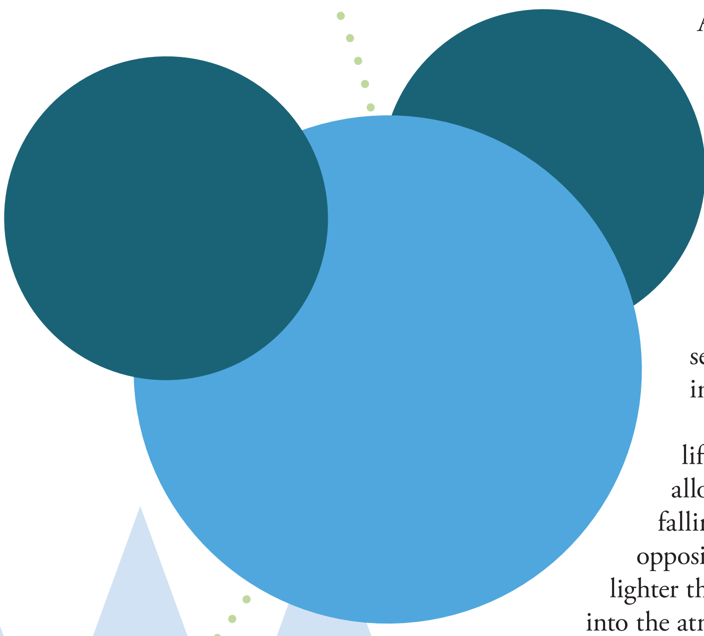
Journey to the Clouds

The life-cycle of a water molecule

By Jerry Horner

Wars have been fought over me. When condensed in the atmosphere, I can refract sunlight to form a rainbow. I am often called the universal solvent. From a molecular standpoint, I resemble Mickey Mouse. Most of my siblings can be found in the Earth's oceans. I may linger just a few feet beneath you, in a saturated zone where I fill the voids in rock and soil. Civilizations historically have been located based on my availability. I can meet with approximately 126,600,000,000,000,000,000,000,000 of my friends in a 1-gal bucket. Have you guessed my name?

I would like to introduce you to a most unique and interesting character. Let's listen as a water molecule provides a brief life synopsis.



Into the Atmosphere

As I lounge near the sun-warmed surface of Apache Lake in Arizona, I can feel that a change is imminent. My temperature drops and my bonds with nearby molecules suddenly are broken as a chemical coup d'état takes place. I am transformed abruptly from my long-held liquid phase to a gaseous form that sends me rapidly ascending into the troposphere.

I love this part of my life-cycle, as it is when I am allowed to soar like a free-falling skydiver, only in the opposite direction. Since I am lighter than air, I am easily whisked into the atmosphere.

I have made this trip countless times before. About 90% of my atmospheric playmates also evaporated from surface water supplies. Most of the other 10% arrived here via transpiration, evaporating from plants and trees. A small percentage cheated by skipping the liquid phase, accomplishing evaporation via sublimation as they were yanked directly from ice or snow. In the end, we all transformed into water vapor, rising via air currents into the atmosphere, where many of us will condense to form clouds.

Rising as water vapor, we cool as a result of lower air pressure. Why is the air temperature cooler on top of a mountain, even though it is closer to the sun? With the Earth at an average of 93 million miles from the sun, climbing a 6,000-ft mountain, in a relative sense, is still 93 million miles away from the sun. The difference in distance is negligible, so the temperature discrepancy must have another cause.

The answer is found in physics, understanding that increasing the pressure on a gas raises its temperature. Barometric air pressure at sea level is about 15 psi, whereas at 6,000 ft, the air pressure drops to about 12 psi. The lower air pressure is a result of the smaller volume of atmospheric air that is pressing down from above. It is similar to what happens when a diver descends into the ocean. As the depth of water increases, the column of water that is sitting on top of the diver increases. This significant atmospheric air pressure differential is the primary reason temperatures on earth decrease as you ascend to higher altitudes.

Clouds are formed when countless numbers of my brothers and sisters in the gas phase condense and coalesce as water vapor to form tiny drops around a nucleus usually consisting of tiny particles of salt, dust or smoke. I am thrilled and fortunate to be so clean and free.

In fact, I am currently part of only 0.001% of the earth's total water volume that is found in clouds and the air in the atmosphere. Ninety-seven percent of my siblings currently are choking on salts in the world's oceans. Only 3% are in some form of freshwater, but 99.7% of that 3% are trapped in glaciers, ice packs or underground reservoirs.

Down to Earth

Sadly, this skyward trek will be a short trip for me, as I am likely to return to Earth in the form of precipitation within about 10 days. As droplets, we are still too small to fall as precipitation, but we continue to combine and grow until we accumulate sufficiently and reach the point at which we can fall back to Earth as a single drop of rain or other form of precipitation.

When I return to Earth, I may infiltrate the ground into an aquifer, from which I might not escape for 10,000 years. However, if I end up in Antarctica, I may not be delivered for hundreds of thousands of years. My ultimate goal, though short lived, is to become virga, which is when I evaporate prior to reaching Earth. This extends my vacation time, and for a water molecule, that is as good as it gets.

A Special Substance

I am unique in so many ways. For example, the solid form of most substances is denser than the liquid phase, but I am different. In freshwater, I generally reach my maximum density at about 39°F. In a body of water, I will sink to the bottom as I cool, but when it nears the freezing point, I expand to become less dense. When I do freeze, I will float or form as ice at the top because I am less dense than my warmer counterparts below. Thus, we freeze as a body of water from the top down.

This is rather fortuitous for aquatic life—if we initially formed as ice below the surface, my liquid-form friends above would remain exposed to the colder air. This would make my comrades far more likely to freeze the entire body of water solid. For the same reason, denser water displaces the ice in your drink, which floats to the top just as an iceberg floats with about 10% of its mass above the water's surface.

Your job as a water improvement professional is to make the limited available freshwater, approximately 1⁄150th of 1% of the total H_2O on our planet, not only better, but also aesthetically pleasing to your customers. I am here to do my part. *wqp*

Jerry Horner, CWS-VI, CI, is regional sales manager for Watts Water Quality. Horner can be reached at hornerjg@watts.com or 800.659.8400.

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