The Not-So-Frozen Elbow River

This is one of my favourite times of year to walk down to the Elbow River and just stand there observing the icy water flow by. The next day I do the same thing, and then the next day, and so on. Observing the river slow as winter settles in and ice increases and decreases depending on temperature fluctuations and the time of day is fascinating and meditative. Since my academic and professional background is all about water, I unfortunately have a hard time just leaving it at "fascinating and meditative." I am always drawn to ponder the physical, chemical and biological forces at work in the river system.

For instance, how amazing is it that as water gets colder it becomes denser and sinks, but that after reaching a seemingly arbitrary temperature (3.98°C), water is less dense and rises until it freezes at 0°C? So, as water travels down the Elbow River, it is slowly cycled from the surface to the bottom and then back up again depending on its temperature. Almost all of the water at the river bottom is 4°C because denser masses sink to the bottom, and everything in the middle is a swirling quagmire of variable temperatures either rising or sinking. My imagination assigns a spectrum of colour to the water molecules depending on temperature and density, and I can almost see the beautiful marbled, ever-changing artistic masterpiece flowing past. Is that completely nerdy? You bet, but I embraced that part of myself long ago.

The next obvious question (to my mind, anyway) is how does the ice form on the river? Ice is a rigid, open framework of hydrogen bonded molecules. The mass of this framework is the same whether it is present as water or ice, but the volume expands by 9% as water becomes ice, making it less dense. Hence, ice (lower density) rises to the surface as water (higher density) flows beneath. Once a layer of ice has formed, it becomes thicker as cooled water molecules freeze and affix to the bottom ice layer.

Now, you may wonder why the whole river does not freeze. There are many factors to consider, but the main reasons are as follows. Ice is a good insulator so the water flowing under its

surface is protected from atmospheric temperatures much colder than 0°C. The next reason is that flowing water is full of potential energy. As it flows, potential energy is transferred to kinetic (heat) energy that resists freezing on a molecular level. Groundwater discharging into the river can also impact the temperature, but I'll leave it here before I bore you too much.

Next time you go down to the river, I invite you to think about these natural forces constantly at work. While the river may seem to follow the bears into hibernation for the season, it is constantly working and churning to equilibrate to the ever-changing environmental conditions.

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