STANDARD DEVIATIONS: Turn Up the Heat!

Greetings,

Hot enough for you? The unprecedented heat dome that has settled over much of the Pacific Northwest has killed hundreds of people and destroyed millions of dollars' worth of crops. The temperatures have climbed higher than any ever recorded.

And still folks stay around, and still plants grow. What would it take to sterilize the region of all life?

Well, that is a question we ask all the time in the lab? Eliminating life from our work is a critical part of reagent preparation and waste management. And, we do it with heat, so we have an idea of what it takes.

121.

That is the temperature (Celsius) that we go to for sterilization. Autoclaves must reach this point under the right pressure and time conditions to kill. It's 250 degrees Fahrenheit!

Why do we have to go so far beyond the boiling temperature of water to get lethal? It has to do with the creative survival strategies of microorganisms. The sporulation that many bugs use to desiccate allows them to laugh at being boiled alive, until we turn up the heat. But for that we need pressure. Since water boils at 100 degrees Celsius at standard pressure, it would not be possible to heat it to any temperature higher than that under standard pressure conditions.

Because temperature and pressure are intertwined, it is necessary to increase the surrounding pressure to 1 atmosphere, or 15 pounds per square inch, above normal pressure in order to increase the effective boiling point of water to 121 degrees Celsius.

The amount of time needed to achieve sterilization depends on how much equipment is in the autoclave to be sterilized. For most lab applications, a time of 15-30 minutes is sufficient to sterilize our media and glassware. Some cycles run longer for waste and special conditions.

Boiling water destroys viruses, protozoa, and bacteria by changing the configuration of proteins, denaturing them. By ruining their enzymes, and membranes, you counteract their ability to be lethal and cause disease.

But the extremophile organisms use proteins that remain stable at both high and low temperatures. The Clostridium bacteria are hyperthermophile pros. The protein molecule of the spore coat provides hyperthermostability, they can keep their structural stability and still function at extremely high temperatures. The interesting part is the protein changes that occur when the temperature drops, and the spore becomes viable.

{How much energy is released here?}

Organisms that thrive in the high pressures of the ocean deeps are using similar protein properties. And a bunch of critters have evolved protective proteins that work at temperatures below water's freezing point.

Spore germination is not well understood. A loss of heat resistance, sudden ion transport (Ca++, especially), heat-labile enzymatic cascades, and rehydration are complex mechanisms still being studied.

Utah Public Health Laboratories use several autoclaves; some are used for media prep, some for waste, some to sterilize reusable tools and instruments. Your facility probably has more than one as well. The sophistication in the different systems illustrate the complexities of sterilization.

{Intricate plumbing required.}

From Grandma's pressure cooker to room-size units in media production or agriculture research, the autoclave is an essential part of our lives and work. They allow us to do good science without contamination and protect the environment from hazardous biological wastes.

Have a great week and be safe,

Bryan

p.s. 121 is the sum of three primes (37+41+43), it is the winning score in Cribbage, and the number of spaces on a Chinese Checkers board.