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Manori Perera and Problems for Automobiles During Sub-zero Temperatures

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WGLT Sound Ideas Interview with Manori Perera, January 29, 2019

Charlie Schlenker: The dangerously cold weather we are experiencing this week creates a playground for chemists, Manori Perera, an Associate Professor of Chemistry at Illinois Wesleyan University, speaks with GLT's Erich Stock to explain some of the phenomena we see when it's this cold, such as boiling water turning instantly to ice.

Manori Perera: We think of water, and we always think of either ice or just the liquid, but like the vapor, when the water becomes going to the gas and it's a vapor and it's in the air, and the temperature surrounding those air – vapor feels the 0 Celsius. So the moment that happens, all the water molecules, they're like little children, they're like cuddled up and the density change and the interaction between the molecules change so they become a solid right away. They don't need to go through the typical phase – Oh, I'm gonna become a liquid. Then, I'm gonna be an ice. It's just the temperature difference of vapor at 0 Celsius. They just become little ice cubes, so that's like hail, pretty much.

Eric Stock: And how cold does it have to be for that to become instant?

Perera: So water freezes at 0 but if you're going from vapor that is just boiled water right now, it's already at 100 Celsius so it first needs to come to 0, and then it freezes. So if it is 0 Celsius outside, it's not gonna happen instantly. So it needs to be below 0 for it to happen right away.

Stock: Then I imagine it 20 below, where we are going to be tonight, that could very well happen then.

Perera: Of course. I think… I was telling my son who is 7, like, if he goes out and like, pass air, like, breathe out—he probably will be able to see little icicles coming out, because it's gonna be so cold.

Stock: Well, sure. And I guess that's the concept behind freeze bubbles.

Perera: Exactly! And I think we don't normally think of these things in advance…umm, this being home owners and stuff. The pipe and just generally running a car, we think, okay, we're gonna start the car and start moving, but all of these things have big implications when the temperature goes down that low because everywhere, I mean, just in air there is water, so everything gonna condense.

Stock: Are there scientific explanations for how freezing cold impacts what we see in our environment and much the technology that we rely on daily. As you said, these are all things that we take for granted, like our car will start, maybe it won't. Road salt also doesn't work at a certain temperature once it gets to near 0 Fahrenheit. Explain how that works. What makes it ineffective?

Perera: So normally what we do is, water freezes at 0, so to make it even lower than that, which we call depression of the freezing point, we add salt. I mean, if you add even just table salt, that has a higher melting point. So what it does is, it kind of makes the water freeze even lower temperatures. So… because it disrupt the water molecules' network by going in between, when you add the salt, so all of a sudden, water molecules don't see another water molecules to, like, solidify. So that kind of depress that freezing point. So, it works for a while, but it can't work infinitely because the salt is already a solid, so you can only lower it to so much going down, and so… I actually don't know what temperature when salt stop working but, like, gravel and stuff is much better at least temperatures than salt but everything will not work.

Stock: In revisiting with Dr. Manori Perera, who is an Associate Professor of Chemistry at Illinois Wesleyan University is who we are discussing the chemistry of severe cold weather and the impact it has on much of what we depend on to get by our daily lives. Diesel fuel can become a problem with yet to 25 below 0 that it can essentially be rendered ineffective if it gets to 25 below 0. How does that happen?

Perera: So this really is awesome because when crude oil is taken out, much of the purified, like, octane weighted goes in to become petroleum. The rest of it, you can end up making diesel, which is a by-product of crude oil. Diesel is not as still as gasoline, because what it has is, some of that crude oil has, like, wax, like, paraffin. So all those wax is in the diesel. At normal room temperature, diesel is a liquid, we really don't see that wax and it, but when it starts freezing, those wax molecules that is in the diesel start solidifying. So all of a sudden, when you lower the temperatures, it become like a slush. And if you keep on making it more – lower, and lower lower in the temperature, those slush – it's gonna end by making little packets of, like balls of wax. And if it goes into the lines, the fuel lines of vehicles, they can actually block the line, so people have to be little bit careful. You have to warm up the cars. And even you do at these temperatures, if you have a diesel car, you wanna be careful that those bigger wax pieces don't go into lines because they can block, that can cause severe damage to engines, and it's all because of those paraffin molecules – the wax molecules that is in diesel. Normally, we like them because it gives a little viscosity like a change in the flow of the diesel, but not when it's cold.

Stock: And what about gasoline?

Perera: I would say that it's purer than diesel.

Stock: So it takes a colder temperature.

Perera: It can handle colder. I – so, rule of thumb is like, diesel freezes before gasoline. I'm gonna assume gasoline has a freezing point of about -40 to -50 degrees, so it can go lower than diesel can.

Charlie Schlenker: That’s Illinois Wesleyan University Professor Manori Perera with Eric Stock. She recommends warming your car’s engine at least 10 minutes when it’s this cold because rubber belts can snap in the cold. She also recommends checking your car’s tire pressure, it will drop in these temperatures.