The science behind ice-melt products

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Gregory Tochtrop's dogs Frankincense (“Frankie”) and Acetaldehyde (“Ace”). Credit: Gregory Tochtrop

As picturesque as winter weather can be, snowy scenes often present a less desirable, slippery companion: ice. It coats our roadways, clings to windshields and serves as a general hurdle in daily life during the coldest months of the year.

Ice-melt products offer a needed solution—but choosing the right one can be difficult. From accelerating the rusting process on vehicles to causing pH levels in slush that can harm pets' paws, the negative consequences of certain products may prompt consumers to think twice.

To learn more about ice-melt products and what people should know, The Daily spoke with Gregory Tochtrop, professor in the Department of Chemistry at the College of Arts and Sciences. A dog parent to two spaniels—Acetaldehyde ("Ace") and Frankincense ("Frankie")—Tochtrop knows firsthand the importance of considering the science behind the products we use when combatting ice.

1. How do ice melt products work?

Ice melt works by changing the "melting point," or the temperature at which solids such as ice will melt. Anything that undergoes the transition from a solid to liquid—such as ice transitioning to water—will almost always form an organized crystal lattice when solid, and that crystal lattice is the hallmark of having a melting point.

Ice melt works to disrupt this lattice. In chemistry, we think of this in terms of intermolecular forces that impact how crystal structures form, and thereby how (or if) the solid appears. When water forms into ice, it creates an extremely regular crystal lattice all based off of two hydrogen bonds in between each water molecule. When you disrupt this lattice by introducing ice melt, it's much harder for water to find enough energy to form a solid. The impact on melting point is all a function of how much concentration of something you can introduce to a solution. Different types of ice-melt products, like different salts, vary in how effective they are at entering the ice structure and moving the needle on the melting point.

2. Why is salt so popular when it comes to melting ice?

Anything that dissolves in water could be used to change its melting point, but there's a simple answer for why we use salt: It's cheap.

Massive salt deposits exist all around the world from dried-up oceans. Take, for instance, the Cargill salt mine underneath Lake Erie, which was the source of most of North America's salt for a very long time. Mines like this provide two major types of salt—calcium chloride and magnesium chloride—and when those dissolve into water, they break up into three different ions.

The amount that your freezing point is depressed is a direct function of the number of ions, or particles, that have to get accommodated into water's crystal lattice structure, so the process these salts undergo offers a straightforward, affordable option. If you were to add something like sugar you wouldn't be successful, because it doesn't break up into particles. The sugar would stay intact as sugar molecules.

3. How does salt affect roadways and cars?

The nature of how salt breaks up, unfortunately, is also the reason why it's so deleterious to cars. When calcium chloride and magnesium chloride react with water, they form calcium hydroxide and magnesium hydroxide, and, thereby, form hydronium ions. Those ions are effectively acidic.

The acid that results in these solutions significantly lowers the pH level of the slush we drive through, which then gathers on roads and the undersides of cars. This accelerates how quickly water and oxygen from the air interact, in essence corroding the iron and aluminum parts of vehicles and creating rust.

4. What makes for a pet-safe ice-melt product?

The acidic pH that certain ice-melt products can cause in slush doesn't only impact cars and roadways; it's also the main reason why some pets

get such sensitive paws over the winter. Calcium chloride is a particularly big offender since it lowers pH levels more significantly.

Likely the best pet-safe deicer is potassium acetate. It's better because it doesn't react with water and change the pH. Sodium chloride is ample and cheap, would be great for melting salt, and also wouldn't cause the pH change, but… it would kill all your vegetation. Potassium acetate is the way to go.

5. What's going on when they 'deice' a plane?

At an airport, chances are you're not going to find salt-based ice-melt products for one major reason: They'd harm the planes just as they cause rust and corrosion on cars and roadways.

Instead, airports turn to potassium acetate when removing ice from runways, and they spray a propylene glycol solution on the planes themselves. While cost prohibitive in other settings, these deicing agents are used because airports are keenly aware of not causing corrosion on planes. You can't afford for a part to rust off!

Provided by Case Western Reserve University

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