**Melting Snow and Ice with Salt**

If you live in an area with a cold and icy winter, you have probably experienced salt on sidewalks and roads. This is because salt is used to melt the ice and snow and keep it from refreezing. Salt is also used to make homemade ice cream. In both cases, the salt works by lowering the melting or freezing point of water. The effect is termed 'freezing point depression'.

**How Freezing Point Depression Works**

When you add salt to water, you introduce dissolved foreign particles into the water. The freezing point of water becomes lower as more particles are added until the point where the salt stops dissolving. For a solution of table salt (sodium chloride, NaCl) in water, this temperature is -21°C (-6°F) under controlled lab conditions. In the real world, on a real sidewalk, sodium chloride can melt ice only down to about -9°C (15°F).

**Colligative Properties**

Freezing point depression is a colligative property of water. A colligative property is one which depends on the number of particles in a substance.

All liquid solvents with dissolved particles (solutes) demonstrate colligative properties. Other colligative properties include boiling point elevation, vapor pressure lowering, and osmotic pressure.

**More Particles Mean More Melting Power**

Sodium chloride isn't the only salt used for de-icing, nor is it necessarily the best choice. Sodium chloride dissolves into two types of particles: one sodium ion and one chloride ion per sodium chloride 'molecule'.

A compound that yields more ions into a water solution would lower the freezing point of water more than salt. For example, calcium chloride (CaCl2) dissolves into three ions (one of calcium and two of chloride) and lowers the freezing point of water more than sodium chloride. Here are some other de-icing compounds:

**Chemicals Used to Melt Ice**

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| --- | --- | --- | --- | --- |
| **Name** | **Formula** | **Lowest Practical Temp** | **Pros** | **Cons** |
| Ammonium sulfate | (NH4)2SO4 | -7°C (20°F) | Fertilizer | Damages concrete |
| Calcium chloride | CaCl2 | -29°C (-20°F) | Melts ice faster than sodium chloride | Attracts moisture, surfaces slippery below -18°C (0°F) |
| Calcium magnesium acetate (CMA) | Calcium carbonate CaCO3, magnesium carbonate MgCO3, and acetic acid CH3COOH | -9°C (15°F) | Safest for concrete & vegetation | Works better to prevent re-icing than as ice remover |
| Magnesium chloride | MgCl2 | -15°C (5°F) | Melts ice faster than sodium chloride | Attracts moisture |
| Potassium acetate | CH3COOK | -9°C (15°F) | Biodegradable | Corrosive |
| Potassium chloride | KCl | -7°C (20°F) | Fertilizer | Damages concrete |
| Sodium chloride (rock salt, halite) | NaCl | -9°C (15°F) | Keeps sidewalks dry | Corrosive, damages concrete & vegetation |
| Urea | NH2CONH2 | -7°C (20°F) | Fertilizer | Agricultural grade is corrosive |

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