Breaking the ice: An overview of de-icing and anti-icing techniques

For the vast majority of Americans and Canadians, the new decade began under several feet of snow, icy roads and difficult travel conditions. It's a not-so-subtle reminder of the need to maintain open travel ways – roads and bridges, airport taxiways and runways – in frigid temperatures. Let's take a look at various methods to break the ice – or prevent the ice – that can make winter travel less of a slippery proposition.

To de-ice or anti-ice?

Anti-icing is aimed at preventing ice from forming while de-icing is designed to remove ice after it begins to accumulate.

De-icing removes frozen contaminants: snow, ice, slush and frost that are already bonded or formed to a surface. Methods of de-icing include mechanical processes (scraping, pushing); heat application; use of dry or liquid chemicals that lower the freezing point of water; or a combination of these techniques.

De-icing fluids can be applied over thin ice or snow pack but are best used early in a storm at their full strength as an anti-icer. There is no need for them to be diluted or heated.

Dry chemicals are best applied at the beginning of a storm and directly over ice or snow-pack to break the bonding effect of the frozen precipitation to the pavement. Dry chemicals may be pre-wetted with brine or other liquids to help them stick to the paved surfaces and to start melting ice more quickly. Once the ice or snow-pack is loose after de-icing, mechanical means are usually recommended to remove it to prevent re-freezing or re-bonding as the de-icer is diluted by melting ice or snow.

The effectiveness of de-icers depends on surface temperature, application rate, the amount of moisture or water present, and the applied concentration. When choosing a de-icer, it is important to review the certification, the effectiveness and how the de-icer works. Also, consider where it will be used: Is there an environmental or corrosion concern? The non-chloride de-icers are safer.

Solid de-icers are generally applied after snow and ice have fallen and bonded to the surface. Solids penetrate through the accumulated pack to the pavement as the de-icer alters its form from solid to liquid. Some solids like

A primer to de-icing chemicals

- **GLYCOL AND GLYCOL/POTASSIUM ACETATE**. Because of environmental reasons, these liquids are being phased out as runway de-icers. Glycol is used primarily today as a wing de-icer. At heavy-use airports, it is collected in holding tanks or ponds so it is not released into the environment.
- **UREA.** This farm fertilizer is not airport grade (technical grade), nor is it certified to FAA AMS 1431B. Its performance is poor and works best in temperatures above 20° F. Urea is environmentally unacceptable by the EPA and banned from U.S. Air Force bases. It does not store well and the cost has escalated dramatically. It is about as destructive to concrete as rock salt.
- **POTASSIUM FORMATE**. This non-toxic salt of formic acid forms water solutions with a high density and a low freezing point. Potassium formate decomposes in the environment resulting in carbon oxides, water and other more stable potassium salts. Potassium formate is available as a 50 percent solution in water.
- **SODIUM FORMATE SOLID**. The granular form works in low temperatures, is dusty and imported to the United States.
- **POTASSIUM ACETATE LIQUID**. This low-freezing-point liquid is the choice of U.S. and Canadian airports. Potassium acetate is used by airports throughout the world on runways, taxiways and peripheral roads and bridges. Potassium acetate has largely replaced glycols at airports. It is a safer and far more environmentally friendly alternative to ethylene glycol and is preferred over propylene glycol at most airport facilities. It may also be used as an aircraft lavatory antifreeze.
- **POTASSIUM ACETATE-BASED (KAC) LIQUID E36**. It is recommended by the EPA as alternative de-icer/anti-icer to glycol and urea and is used in most major airports in the United States, Canada and Europe. Liquid is a 50% solution and is applied at 0.25 to 1.5 gallons per 1,000 square feet. Used by most airports worldwide, it is effective to -20° F, works quicker than urea and glycols (only 5-10 minutes); and is less slippery than glycols. Performance is enhanced with thin ice, warmer temperatures and fractured ice.
- **ANHYDROUS SODIUM ACETATE SOLID (NAAC)**. This sodium acetate-based solid runway de-icer meets FAA-approved specifications for use by commercial airports and military bases. Benefits are low corrosion, effective performance, minimum dust, less compaction in storage, even spread patterns, low toxicity and biodegradabilty. Also used on parking structures and bridges where chloride de-icers should be avoided.
- **POTASSIUM ACETATE/BIO-BASED (SUSTERRA™) NEW LIQUID BX36.** The propanediol provides low conductivity and less ASR expansion. (ASR is the abbreviation for a naturally occurring phenomenon called alkali-silica reaction. Commonly defined, it is the expansive deterioration of concrete due to a chemical reaction involving concrete aggregate and cement paste.)
- **SODIUM ACETATE/BIO-BASED (SUSTERRA) NEW PROPANEDIOL (PDO)**. Liquid NX360 offers low conductivity and lower freeze point. XT360 is bio-based (Susterra).

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anhydrous sodium acetate actually give off heat (exothermic reaction) as they dissolve.

Solid de-icers are available as either pellets or granules. Pelleted de-icers are harder, less dusty and tend to spread more evenly. Pellets and granules stick to the surface and have less bounce during application when applied on wet or light-snow-covered surfaces.

Liquid de-icers are generally used as "anti-icers." The choice of the right chemical for anti-icing applications is dependent upon a number of factors, including the area's climate, chemical availability as well as environmental concerns. A fundamental characteristic of anti-icing chemicals is the ability to reduce the freezing point when added to water.

Anti-icing on roadways prevents ice and snow from adhering to the pavement, thus allowing easier removal by mechanical methods (snowplows). Brine or wetted salt is usually applied shortly before a snowstorm arrives. If performed properly, anti-icing can significantly reduce the amount of salt required to clear snow from a roadway.

Generally, anti-icing techniques are more efficient than de-icing because less energy is needed – therefore, less chemical is used – to prevent a bond from forming than to break it. Anti-icing can be applied before a storm hits or early in the storm. Maintenance costs are lower, and there is a reduced environmental impact.

Unfortunately, anti-icing measures alone are not enough to keep the paths of commerce and education open. A balance of anti-icing and de-icing methods is necessary. Understanding when and how to apply the appropriate chemicals for greatest effect comes by observing and measuring the combination of environment, chemical, application and result. This scientific approach is evident every winter day as we drive to work or board a plane to take us to sunnier and warmer climes.