

Science around us

Innovations from BASF illustratively explained



Ice-free through the winter

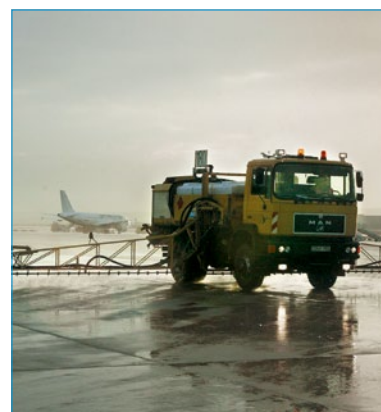
Formic acid enables environmentally friendly deicing of runways and roads – and is successful in many other applications

Ants, jellyfish and ground beetles use it to defend themselves and when hunting. How effectively it can protect stinging nettles against predators is something many of us have experienced first hand: the substance in question is formic acid. The acrid and pungent smelling liquid produced by nature already awakened people's curiosity many centuries ago. The English naturalist John Ray first isolated the simplest of the carboxylic acids in 1671. He heated red wood ant bodies in a glass flask and obtained in the distillate an acidic liquid he called formic acid. The first successful chemical synthesis was achieved by the French chemist Marcellin Berthelot in 1855. BASF's interest in formic acid began in the 1920s. When an increasing number of industry sectors started using carboxylic acid, the chemical company launched large scale production in 1935. Today, there are hardly any limits to the use of formic acid. "It's a real all-rounder," emphasizes Dr. Tatjana Levy, Innovation Manager in BASF's Intermediates division. The acid has a history of successful use in numerous applications over several decades. In animal nutrition it preserves feeds, it is used in leather and textile manufacture and is a constituent of oilfield chemicals. "And we are constantly discovering new applications that we are developing together with our customers," adds Levy.

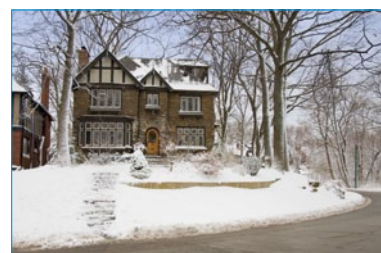
Airports place high demands on deicing agents

European airports are also among the users. "They have been using the salts of formic acid for more than ten years to deice their landing strips and taxiways," explains Levy. The salts, also known as formates, make sure that water doesn't freeze at zero degrees Celsius as it usually does. Depending on the concentration of the deicing agent, the freezing point is reduced to as much as minus 50 degrees Celsius and is then much lower than the outdoor temperature. In this way, formates rapidly remove thin layers of ice and effectively prevent new snow from sticking to the landing strip or a new layer of ice from forming. Formates are also very eco-friendly. "If the salts of formic acid enter the airport waste water treatment plant together with the melt water, their waste water polluting effect is much less than that of other deicing agents because of their good biodegradability and low oxygen demand during the breakdown process," says Levy.

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Contact
Holger Kapp
Corporate Media Relations
Phone +49 621 60-41040
Fax +49 621 60-92693
holger.kapp@basf.com



Airport deicing with formates. The salts of formic acid rapidly remove thin layers of ice and effectively prevent new snow remaining on the landing strip.



Local and municipal authorities also use formates to deice roads, bikeways and sidewalks in sensitive areas such as boulevards with mature tree stocks or in districts with many historic buildings.

Text, photos, graphic and animation with sound are available at:
www.basf.de/science_around_us

BASF SE
67056 Ludwigshafen, Germany
Phone +49 621 60-0
Fax +49 621 60-20129
<http://www.basf.com>
E-mail: presse.kontakt@basf.com


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The snow clearing service of Zurich airport has been using formates since 2005. “We place particularly high demands on deicing agents for safety and environmental protection reasons,” emphasizes Hanspeter Moll, Head of Airfield Maintenance Operations at Zurich airport. “They must deice runways and taxiways rapidly and lastingly, have good material compatibility and also be eco-friendly. Our experience has shown that the salts of formic acid meet these requirements better than all other deicing agents.”

Local authorities increasingly aware of formate benefits

The positive experiences of airports have made local and municipal authorities increasingly aware of formates as an alternative deicing agent. Snow clearing services in Scandinavia, Switzerland and Austria use the organic salt to deice their roads, bikeways and sidewalks in sensitive areas such as boulevards with mature tree stocks or in districts with many historic buildings. The City of Basel has been using the thawing agent for many years to remove residual snow from its artificial turf areas. “We first clear the snow and ice mechanically,” explains Eric Hardman, responsible for sports facilities at Basel City Sports Office. Formates are then applied to melt the remaining thin layer of snow. Their good deicing performance makes sure the sports ground is ready for use again in a short time. “We were also impressed by the fact that the salts of formic acid are also biodegradable at low temperatures and do not affect the athletes. Moreover, artificial turf grounds and sports utensils like balls, rackets, goalposts or nets survive the cold season undamaged when formates are used as deicing agents,” says Hardman.

Although winter clearance using formates is more expensive than with ice-melting salt or slippage preventing agents like grit or sand, the procurement costs are not so high when the follow-on costs of the various deicing agents are factored in. Sodium chloride-based ice melting salt disturbs the water and nutrient balance of plants in the soil. Its corrosive effect also damages buildings, roads and bridges. The effectiveness of slippage preventing agents is controversial, as their use increases particulate pollution in cities and its cleanup is laborious. The salts of formic acid, on the other hand, are eco-friendly, hardly corrosive and reliably keep roads and walkways free from ice and snow – without undesirable side effects. Replanting of trees or shrubs or expensive repairs to buildings after the winter are no longer necessary. 

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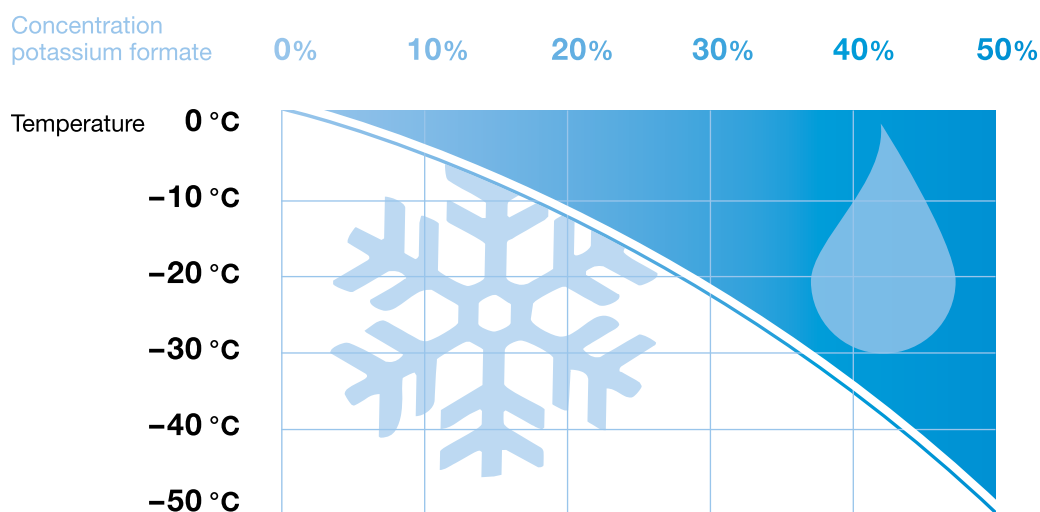
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Nature is and remains the largest producer

BASF is one of the world's leading manufacturers of formic acid. Whereas in Asia, South America and Southern Europe the majority of the acid is used for leather processing, in Central and Northern Europe the main purchasers are agriculture and the animal feed industry. BASF operates production plants for formic acid in Ludwigshafen, Germany and Nanjing, China. Another facility is planned to come on stream in 2014 at the Geismar site in the US Federal State Louisiana. The company will then have increased its annual capacity to more than 300,000 metric tons.

But this still doesn't make BASF the largest producer of formic acid. This is and remains the privilege of the countless animals and plants which produce more formic acid annually than all the factories in the chemical industry put together – and have been doing so for many millions of years.

Change in melting point as a function of the formate concentration



The higher the concentration of the potassium formate, the further the melting point of the water is reduced.

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See Info Box ►

Further information can be found at:

<http://www.intermediates.basf.com/chemicals/formic-acid/index>

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The Info Box

Acidic all-rounder – the main uses of formic acid

Formic acid and its salts have been used successfully for many decades as eco-friendly solutions in numerous applications.

Cleaning

Formic acid cleans, descales and derusts production plants. Breweries, dairies and wineries, for example, use the carboxylic acid to clean water tanks, boilers or drums, and it can also be used in surface cleaning at home. Formic acid also has antibacterial action.

Leather processing

In the leather industry, formic acid supports the high quality processing of animal hides. The acid penetrates rapidly and homogeneously into the leather, ensuring consistent tanning performance in the hides. Formic acid also helps to permanently fix dyes and reduces tanning agent consumption.

Textile processing

The textile industry uses formic acid to regulate the pH in the pretreatment, finishing and cleaning of cotton and in other applications. Compared to other acids, only small amounts of formic acid are needed to obtain the desired pH.

Animal feed preservation

The animal feed industry uses formic acid to improve the preservation of forage. For example, the acid enhances the effect of lactic acid bacteria in the ensiling of green fodder and improves the shelf-life of the feed. After mowing, the green fodder is fermented in silos together with the acid, covered airtight and stored. When the formic acid has done its job, it decomposes into carbon dioxide and water. With its antibacterial action, the acid inhibits the growth of microorganisms and algae in drinking water for poultry.

Drilling fluids

Formates, the salts of formic acid, have a relatively high density. This makes them an important ingredient of drilling fluids, for cooling down the fluids and stabilizing bore holes in natural gas and petroleum prospecting. The organic salts help to reduce operating costs and maximize the hydrocarbon yields.

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Contact
Holger Kapp
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Phone +49 621 60-41040
Fax +49 621 60-92693
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