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Environmentally Safe Liquid Runway Deicer

Introduction

There is a new class of runway deicers. Potassium acetate was aproved in November 1991 for airside use by the FAA. No longer are ethylene glycol, propylene glycol, urea, or glycol-urea mixtures the best available technology to effectively control the problems of runway icing. Potassium acetate can provide exceptional performance in the most extreme conditions without environmental degradation. The problems in storing, using, and recovery of glycol based deicing fluids are well known. Potassium acetate is a deicing alternative that avoids most storage and handling problems. Cryotech Deicing Technology is a leading supplier of potassium acetate. This report will address the following topics concerning potassium acetate runway deicers:

- Composition
- Performance
- Corrosion
- Toxicity
- Biodegradation
- Biological Oxygen Demand
- Overall Comparison

Composition

Cryotech E36™ Liquid Runway Deicer is potassium acetate, a simple mixture of acetic acid (vinegar) and potassium hydroxide. A proprietary mix of corrosion inhibitors is added to the solution to insure complete compatibility with concrete, steel, and aircraft materials. The product as produced has the following properties:

Composition	50% minimum potassium acetate by weight plus corrosion inhibitors
Appearance	Clear, colorless, mobile liquid, free of suspended matter
Density	10.4 to 10.8 lb/gal at 68 °F (20 °C)
Viscosity	10 cp (maximum) at 68 °F (20 °C); 20 cp (maximum) at 32 °F (0 °C)
Flashpoint	Nonflammable
Freeze Point	Less than -58 °F (-50 °C)
Miscibility	Complete miscibility with water
Storage	Should be stored and handled in its original container or in equipment made of polyethylene, stainless steel, lacquer lined mild steel or glass.

Performance

E36 does an excellent job of melting ice as well as breaking the bond between pavement and ice or snowpack. Snowplows can easily remove the resulting slush without damage to the runway or excessive wear on the snow removal equipment. In tests at Eielson Air Force Base in Anchorage, Alaska[1], a runway was cleared of ice and packed snow when air temperature was -27°F. Refer to the following table for recommended application rates for melting ice and snow. Of course, actual application rates will vary with a variety of field conditions as well as experience of the snow removal crew.

Application Rates (gallons/1000 ft^2) for Deicing

Packed Snow & Ice Depth, Inches	Air Temperature 20°F - 32°F	Air Temperature 10°F - 20°F	Air Temperature Less than 10°F
2 to 3	3.7	4.6	9.1
1 to 2	1.8	2.7	6.0
1/2 to 1	1.2	1.8	3.0
Less than 1/2	0.9	1.2	1.8
Glare Ice	0.9	1.2	1.8

While E36 is proven to be an effective ice melter, it can also be used in smaller quantities as an *anti-icer*. In this mode, a thin film of E36 on the surface of the pavement prevents the bond between ice and pavement thereby allowing easy removal of snow and ice[2]. Suggested application rates for runway anti-icing are 1/3 to 1/2 gallons per 1000 ft^2.

E36 does not cause the runway to be slippery. Fricition tests conducted by the UK Department of Transport Road Research Laboratory in 1987 indicate that potassium acetate actually increases runway traction when compared to conventional glycol based deicers.

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1 "Report of Findings on the Informal Testing of the Batts De-Icing System and E36 De-Icing Chemical", Department of the Air Force, Pacific Air Forces, Eielson AFB, AK, November 14, 1991.

2 Letter report on the first use of potassium acetate at St. Louis Lambert International Airport, William Korte, Airfield Administrator, July 30, 1992.

Corrosion

E36 is not corrosive to air-entrained concrete, asphalt, structural steel, steel reinforcing and aluminum. In addition, E36 meets or exceeds the corrosion limits set by AMS 1432, a specification which sets minimum standards for potassium acetate deicers used on taxiways and runways.

Toxicity

E36 is essentially non-toxic. Acute toxicity tests[3,4] have been conducted on solutions of potassium acetate with corrosion inhibitors similar to E36. All tests resulted in LC50 greater than 1000 mg/L which indicates a low level of toxicity. The product does not contain any hazardous components as described by SARA Title III section 302. Excess product or spills may be absorbed and disposed in sanitary landfill unless prohibited by local regulations.

At delivered concentrations, the pH is about 11 which is mildly caustic. We recommend the use of gloves and protective glasses when using E36.

Biodegradation

Potassium acetate decomposes into a potassium ion and an acetate ion. The acetate ion decomposes into carbon dioxide and water. This process begins soon after exposure to air and is accelerated by higher temperatures. Figure 1 shows comparative 5-day degradation rates of potassium acetate (KA) compared to other common deicing chemicals. At low temperature, potassium acetate breaks down more rapidly that all other deicers and about 10 times faster than ethylene glycol. At 20°C, approximately 85% of potassium acetate biodegrades within the 5 day period. Another Cryotech product, CMA (Calcium Magnesium Acetate), biodegrades faster at high temperatures, and is the appropriate solid deicer to replace salt and urea, but CMA does not compete with liquid deicing products because of slower performance.

Biological Oxygen Demand

The total biological oxygen demand for E36 is 0.33 gm O_2/gm of product. Figure 2 presents a comparison of total biological oxygen demand for E36, ethylene glycol plus urea (UCAR™, a trademark of Union Carbide), and propylene glycol. In addition to requiring less

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[3] "Onorhynchus mykiss, 96 hour acute toxicity test using Cryotech GS4 Heat Transfer Fluid", Test No. 44-1, Northwestern Aquatic Sciences, July 9, 1992.

[4] "Fathead Minnow, (Pimephales promelas), 48 hour acute toxicity test using Cryotech GS4 Heat Transfer Fluid", Test No. 441-2, Northwestern Aquatic Sciences, July 9, 1992.

total oxygen to biodegrade, the graph gives an indication of the rate at which oxygen is needed for the process. Any organic deicing chemical can cause oxygen depletion in small ponds or streams, but E36 offers an advantage since the total oxygen demand is less for an equivalent or better performance level. In larger ponds, or aerated streams, E36 is not expected to cause significant oxygen depletion.

Overall Comparison

The following chart gives a qualitative summary of issues related to environmental acceptability for a runway deicing fluid.

	Propylene Glycol	**Ethylene Glycol**	**Urea**	**Potassium Acetate**	**CMA**
Human Toxicity	Good	Fair	Good	Good	Good
Aquatic Toxicity	Good	Good	Poor	Good	Good
Low Temp. Degradation	Poor	Poor	Poor	Good	Good
Acceptable Degrades	Poor	Poor	Poor	Good	Good
Low BOD	Poor	Fair	Good	Good	Fair
Acceptable Wastewater	Poor	Poor	Fair	Good	Good

Therefore, potassium acetate is a high performance runway deicing fluid that also provides the benefits of good environmental compatibility.

BOD

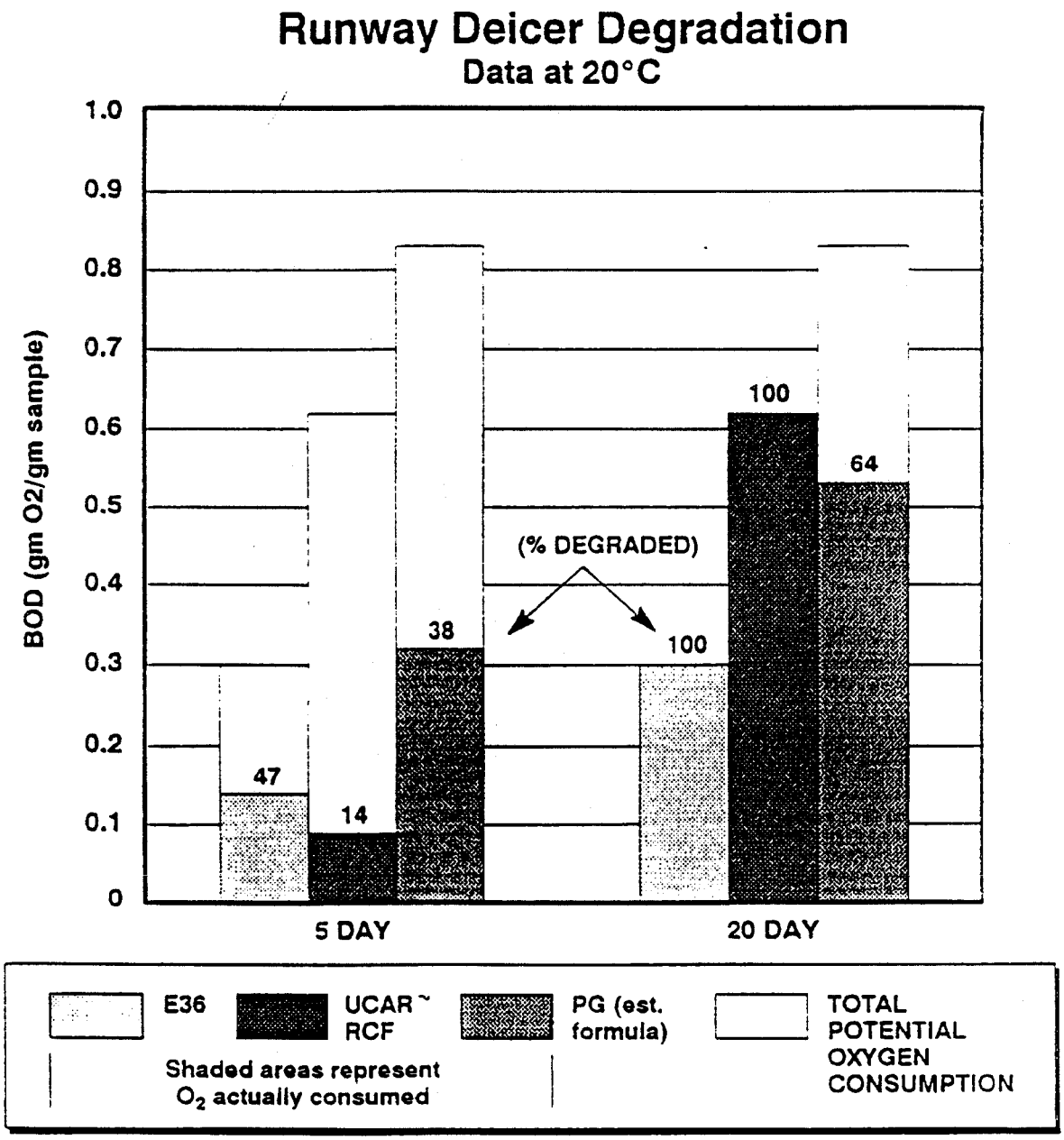
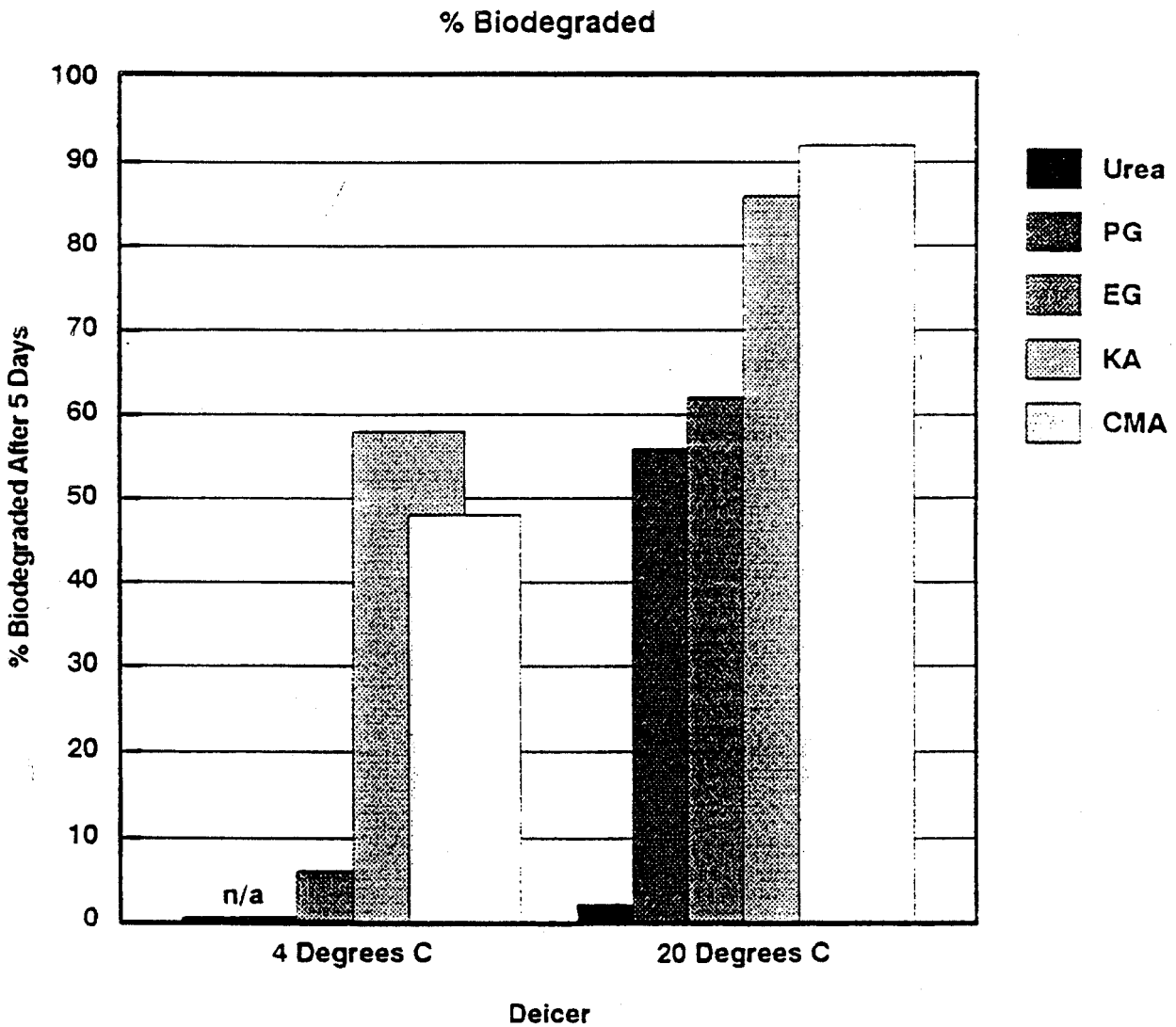

Runway Deicer Degradation
Data at 20°C
BOD (gm O2/gm sample)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
47
14
38
100
64
(% DEGRADED)
100
5 DAY
20 DAY
E36
UCAR™ RCF
PG (est. formula)
TOTAL POTENTIAL OXYGEN CONSUMPTION
Shaded areas represent O_2 actually consumed

FIGURE 2

Biodegradation



Denmark Roads Report
n/a = Not Available

FIGURE 1