Comparison of Ethylene Glycol- and Propylene Glycol-Based Aircraft Deicing Fluids

Both ethylene glycol- (EG) and propylene glycol- (PG) based aircraft deicing fluids (ADFs) consist of the base glycol plus water and additives. Operationally, EG-based fluids perform better. Less EG is required to produce the same freezing point as PG. Additionally, lower viscosity means EG-based fluids provide better aerodynamic performance at colder temperatures. As a result, EG-based fluids have superior Holdover Times (HOTs) compared to PG-based fluids, as presented by the SAE G-12 HOT Committee in May 2017.

Mammalian Toxicity

EG and PG both have low-to-moderate acute toxicity. If ingested in a large, single oral does, EG is more toxic to mammals than PG. However, oral dosing is an unlikely route of exposure during deicing. In Canada, EG fluids have been used safely for many years, confirming operator procedures can appropriately manage this risk. Studies have shown that exposures during deicer applciation are well below occupational exposure limits; however, this may not apply to every setup and situation. For most conditions, respiratory protection should not be necessary.

Table 1: Summary of EG- and PG-based Fluids Toxicity Concerns

	EG-based Fluids		PG-based Fluids	
Acute toxicity	🟡	Oral human LD50 (est.) 1.6 g/kg, Cat 4 Moderately toxic; large dose may cause death.	🟢	No acute toxicity.
Irritation (eye, skin, inhalation)	🟡	Proper PPE prevents irritation.*	🟡	Proper PPE prevents irritation.*
Skin sensitization	🟢	Not a skin sensitizer.	🟢	Not a skin sensitizer.
Genotoxicity	🟢	Non-genotoxic and non-mutagenic in in-vitro and in-vivo assays.	🟢	Non-genotoxic and non-mutagenic in in-vitro and in-vivo assays.
Reproduction	🟡	Although not a reproductive toxicant, EG has been shown to cause developmental toxicity in rodents, but not rabbits (and likely not in humans).	🟢	Not a reproductive or developmental toxicant.
Repeat Dose	🟡	Systemic kidney damage at high oral exposures.	🟢	No adverse effects observed in long-term animal studies.
Carcinogenicity	🟢	Not carcinogenic.	🟢	Not carcinogenic.

🟢 No safety concerns
🟡 Minor safety concerns, addressable by industry safety standards
🔴 Significant safety concerns

*Studies have shown that in normal operations, exposure is at concentrations less than the occupational exposure limit and not at concentrations where irritation would occur. However, if employees are experiencing discomfort or applicable exposure limits are exceeded, then the recommended respiratory protection for applications is an air purifying respirator with organic vapor/P95 pre-filter cartridges.

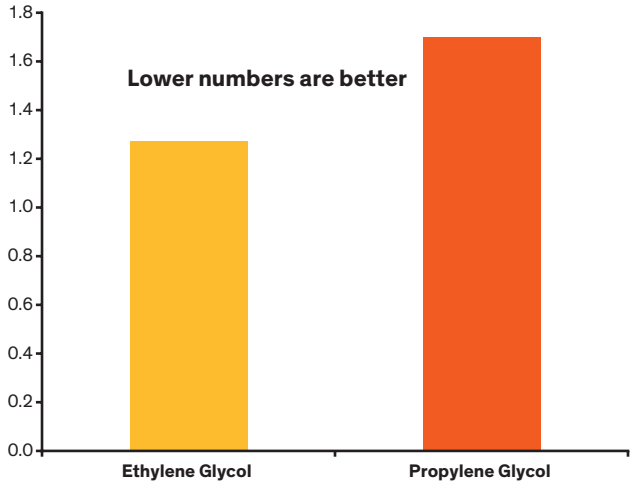
Environmental Properties

EG-based fluids in concentrated form generally demonstrate better aquatic toxicity than PG-based fluids; however, both are non-toxic. Mixtures of EG-based ADFs exhibit less air emissions than PG-based fluids.[1]

Both EG and PG are biodegradable in the environment and neither bio-accumulates. PG has higher Theoretical Oxygen Demand and requires a higher usage concentration. The net effect is 30-45% higher Biochemical Oxygen Demand for airport operations using PG rather than EG on an equivalent freezing point basis.

Chart 1: Theoretical Oxygen Demand (ThOD) - Net Effect of EG versus PG on BOD Loading

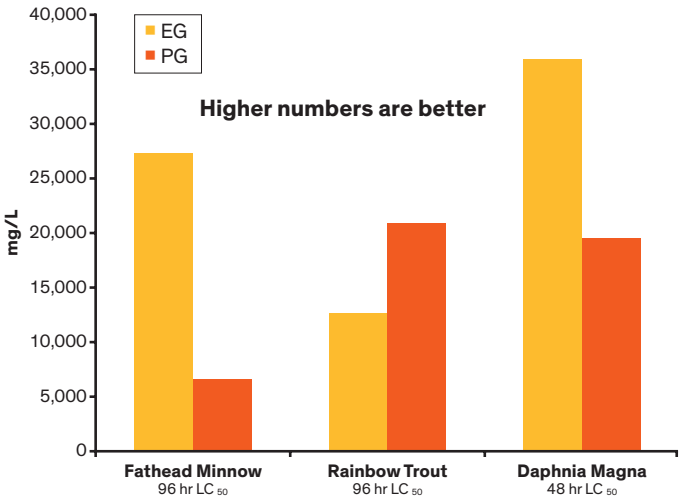
Mg of Oxygen Required to Degrade 1 mg of Glycol



The lower the number, the less oxygen depleted from receiving waters. PG has higher Theoretical Oxygen Demand and requires a higher usage concentration (5-15% due to PG's higher MW). Net effect is 30-45% higher Biochemical Oxygen Demand (BOD) for airport operations using PG rather than EG on an equivalent freezing point basis.

ThOD: 1.68 (PG)/1.29 (EG) = 1.30 (30% less ThOG for EG)

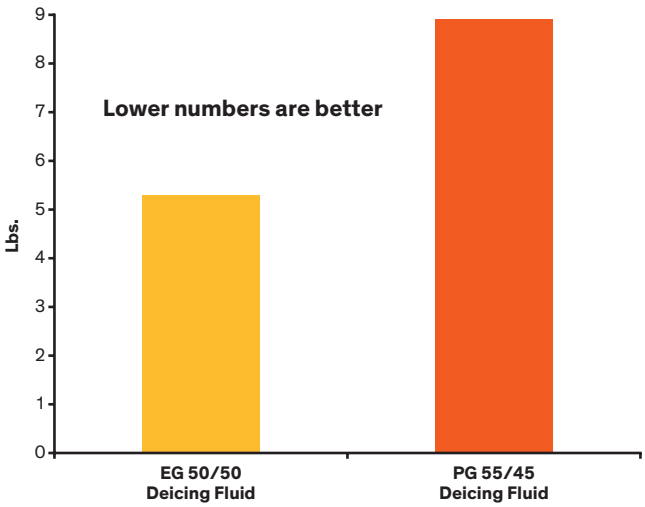
Chart 2: Aquatic Toxicity: UCAR™ Deicing Fluids in Concentrated Form (92% EG, 88% PG)



U.S. Fish and Wildlife Service Classification System for Acute Exposures defines "relatively non-toxic" as anything above 1000 mg/L

Chart 3: Air Emissions (lbs. glycol per 10,000 gallons applied)

Mixtures of EG-based ADFs exhibit less air emissions than PG-based fluids



[1]McCready, David. "Estimation of Glycol Air Emissions from Aircraft Deicing." 91st Annual Meeting of Air & Waste Management Association, San Diego, California, 1998

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