HazEL

ASDEI™ Risk Analysis Prepared for Pyper Vision

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Summary

An analysis was conducted on the proposed airfield defogger, ASDEI^{TM,} using the HazEL methodology. Data from various public databases were used to calculate toxicity, exposure, and emerging concern scores, relative to fifteen other chemicals expected to be found on and around airfields. ASDEI was found to have the lowest toxicity score but data on chronic aquatic toxicity were absent. Suitable data on acute inhalation toxicity were unavailable but it has been previously reported that occupational exposure causes no noticeable adverse effects.

The exposure score was higher than most of the other chemicals in the analyses, due to its low degradability. ASDEI is not expected to biodegrade readily but biodegradation has been observed experimentally, particularly under anaerobic conditions. Bioaccumulation is also not expected, due to the physical properties of the product and this is supported by the low reported octanol-water partition coefficient. The quantity of ASDEI that Pyper Vision use per application is below 2 g/m^2.

The risk to human health and the environment from the use of ASDEI as an airport defogging agent is therefore considered to be low, especially when considered within the risk context of products and substances being used at airfields in New Zealand and globally.

Introduction

Pyper Vision is proposing to commercialise a product for use as an airfield defogging agent. Similar products have been widely used as soil additives and in drinking water treatment.

The product is intended to be spread over affected areas from unmanned aerial vehicles, clearing fog by absorbing moisture as the product settles to the ground. The designated dispersal rate is 0.15 g/m^2 per run and maximum dispersal amount is 20 kg per run.

Hazard Evaluation Ltd (HazEL) has undertaken a risk assessment on this substance in the context of its intended use. The HazEL methodology is designed to simplify the process of comparing chemical products and substances by providing both relevant data and a robust methodology, and the outputs are easy to interpret and communicate.

Methodology

Substances are evaluated on three primary dimensions: toxicity, exposure, and emerging concern. Thirty-four toxicity parameters and nine exposure parameters are used, representative of key environmental and human health measures, and consistent with international standardised methodology for assessing environmental and human health risk. The tool also uses four parameters to express 'emerging concern'. The methodology is designed with sufficient coverage and inbuilt redundancy so that when data for some parameters are unavailable, a robust comparison can still be made, thus the tool can compare like-with-like even when different data points are available.

The toxicity parameters cover GHS classifications, data from reputable studies, and regulatory limits set by government bodies, relating to both human and environmental health. A user-changeable weighting scheme allows for preferred data sources to be prioritised. These parameters are also categorised as acute/chronic and mammalian/aquatic to refine the prioritisation process with respect to end-use scenarios, using relative weightings. In populating these parameters, priority is given to data gathered from common model species, to ensure uniformity among values for substances being compared. Exposure limits from multiple regulatory bodies enable the use of those most relevant to the user's locality.

The exposure dimension includes measures relating to degradability, mobility, bioaccumulation, volume of use, and recorded presence in water monitoring programmes.

Raw data are drawn from several reputable sources and appropriately transformed (by log-transformation and normalisation) to a scale from 0 (least concern, out of the substances within the group) to 1 (greatest concern).

Measures of emerging concern are derived from appearances in academic journals published by Taylor and Francis Publishing Group and reflect not only the number of references to a particular substance but also their change over time.

Selection of chemicals for the analysis

In addition to ASDEI, 15 other substances were included in the analysis (Table 1), to provide a context for risk. These substances are anticipated to be present on and around airfields and include cleaning products, de-icing agents, fire suppressants, jet exhaust components, a widely-use herbicide, and components of aviation-related formulations (e.g., solvents and surfactants).

Table 1. Chemicals used in the analysis.

Name	**CASRN**	**Use**
ASDEI	9003-05-8	Defogger
Ethylene glycol	107-21-1	De-icer
Propylene glycol	57-55-6	De-icer
Potassium formate	590-29-4	De-icer
Sodium acetate	127-09-3	De-icer
Triethanolamine (TEA)	102-71-6	De-icer
Ethoxylated C12-18 alcohols	68213-23-0	Surfactant
1-Bromopropane (1-BP)	106-94-5	Aircraft cleaner
Trans-dichloroethylene	156-60-5	Solvent
Bromochlorodifluoromethane (BCF)	353-59-3	Fire suppressant
Perfluorohexanoic acid (PFHxA)	307-24-4	Fire suppressant
Glyphosate	1071-83-6	Herbicide
Benzene	71-43-2	Jet exhaust component
Formaldehyde	50-00-0	Jet exhaust component
Ethylene	74-85-1	Jet exhaust component
2-butoxyethanol (EGBE)	111-76-2	Solvent

Degradation products of ASDEI were not included in the analysis. Although one of these is known to be neurotoxic, it is expected to comprise only a minor fraction of degradation products and is readily biodegradable.

Results

The Pyper Vision dataset compares ASDEI and 15 other chemicals likely to be used or found on airfields. This analysis compared parameter values between the chemicals and calculated scores on the three HazEL dimensions: toxicity, exposure, and emerging concern. The parameter values provided for ASDEI are shown in Table A1 (Appendix).

The result of this analysis is shown in Figure 1. The highest toxicity score was awarded to the fire suppressant, bromochlorodifluoromethane (BCF), while ASDEI received the lowest toxicity score. However, the exposure score for ASDEI was similar to perfluorohexanoic acid (PFHxA) and higher than all the other chemicals in the analysis.

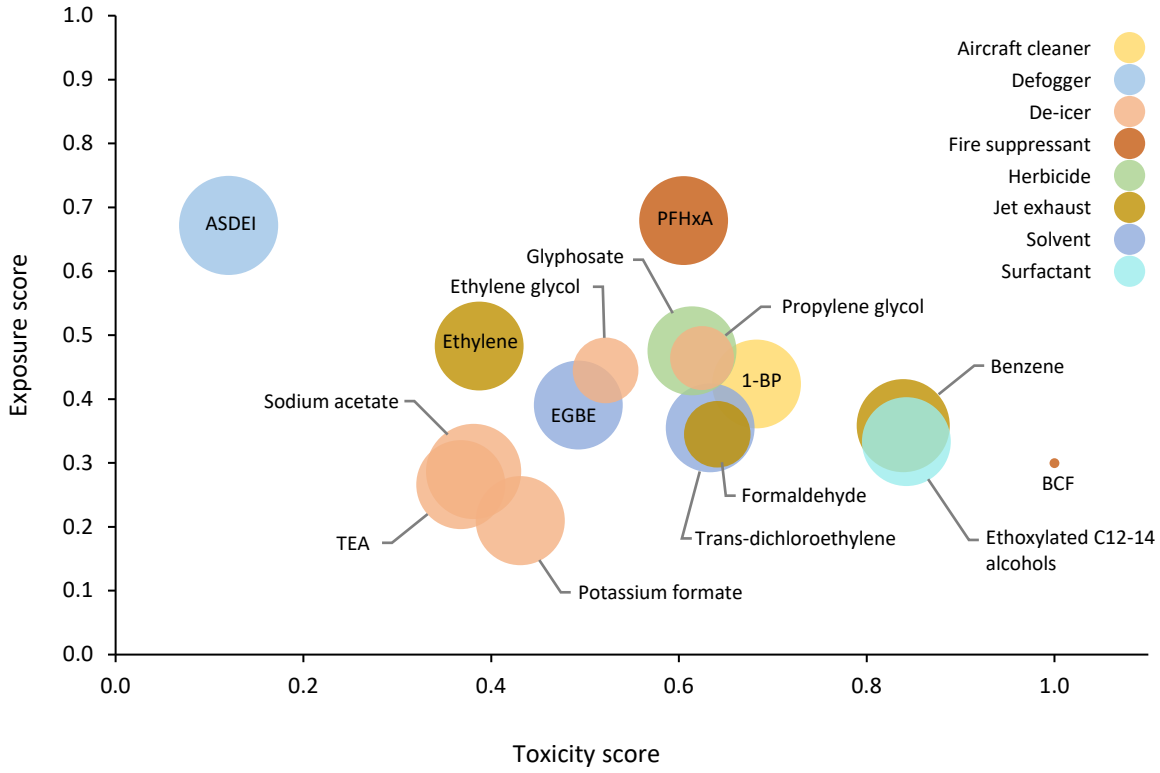

Figure 1. Results of the analysis for ASDEI and 15 other chemicals in regular use at airports and airfields, colour-coded by use. Bubble size indicates relative magnitude of emerging concern scores. Default weightings: 15% each for acute mammalian and aquatic toxicity and 35% each for chronic mammalian and aquatic toxicity components.

To assess the potential impact on aquatic environments, the toxicity component weightings were adjusted. Since no chronic aquatic toxicity data were available for ASDEI, the acute aquatic toxicity component was given a 100% weighting and the analysis re-run (Figure 2)[1].

This changed weighting resulted in a rearrangement of the chemicals on the toxicity dimension. The toxicity score of ASDEI was still lower than most of the other chemicals and similar to those of the de-icers.

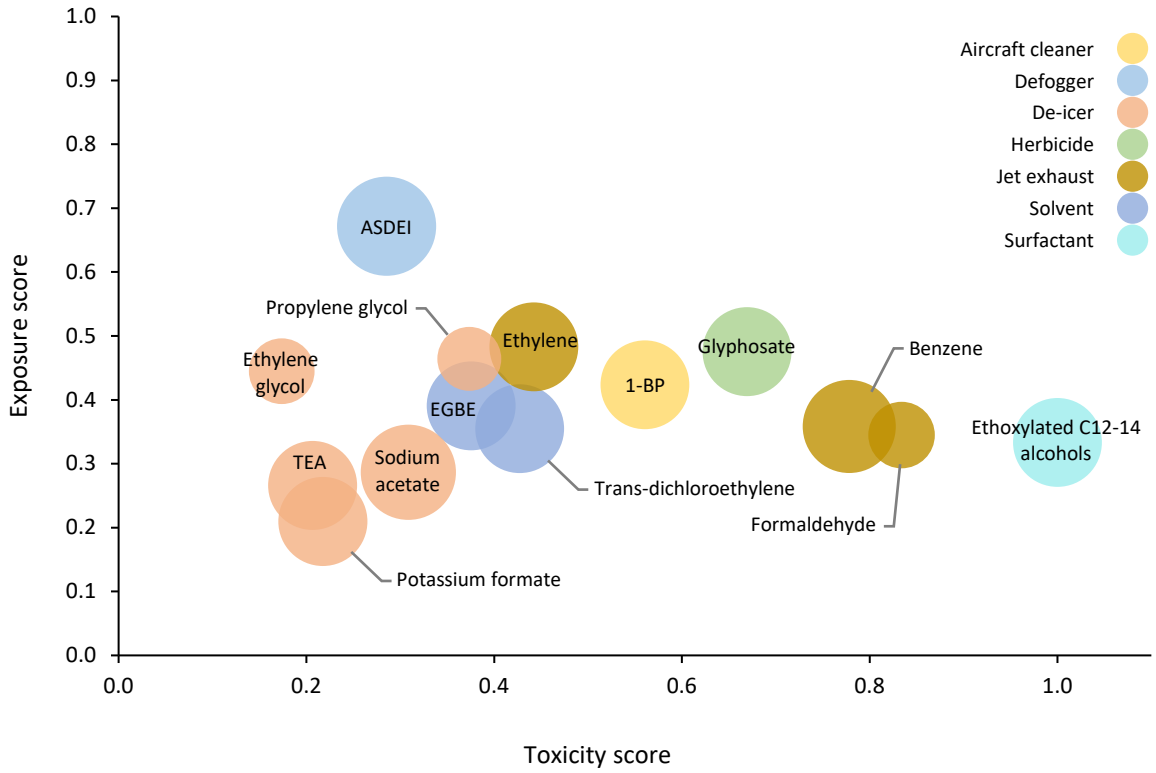

Figure 2. Results of the analysis for ASDEI and 15 other chemicals in regular use at airports and airfields, colour-coded by use. Bubble size indicates relative magnitude of emerging concern scores. Toxicity components weightings were adjusted to 100% acute aquatic toxicity (no chronic and/or mammalian toxicity parameters have been included).

[1] Note that scores were not calculated for the two fire suppressants, BCF and PFHxA, since these compounds have no available data for acute aquatic toxicity.

Discussion

Based on available data, ASDEI presents a low toxicological risk, i.e. presents minimal harm to human health and organisms within the environment.

However, the exposure score indicates some potential for bioaccumulation and persistence due to low mobility and/or degradability.

Toxicity

The acute oral LD_{50}[2] (4000 mg/kg) likely represents a significant overestimation of risk as the only available data come from a study in which this was the maximum dose administered and no mortality was observed, so a lethal dose could not be properly established. However, the (user-supplied) GHS classification into Category 4 (guideline values: $300 < LD_{50} \leq 2000$ mg/kg) suggest that data indicating a lower estimate may be available, possibly outside of the public domain (e.g., confidential reports). Notwithstanding, the data, along with a chronic mammalian oral toxicity value of 500 mg/kg, indicate a low oral toxicity hazard to humans.

Although the preference within the HazEL methodology is to always use toxicity data relating to rats, the only available mammalian value for acute dermal LD_{50} was from an experiment using rabbits. However, given the physical properties of ASDEI it is not expected to be absorbed dermally.

There is no data regarding acute inhalation toxicity, but reports into workers exposed to the dust of similar products show no adverse effects.

Re-weighting the toxicity components to focus on acute aquatic effects demonstrated that the acute hazard potential for ASDEI in the aquatic environment is relatively low. No suitable endpoint data (i.e., 48-hour EC_{50}) for chronic aquatic toxicity were available but chronic effects on *Daphnia*[3] have been reported at concentrations as low as 1 mg/L. There are no observed effects from an ASDEI-type compound on mortality in adult copepods[4] but some developmental effects in early life stages have been found, likely because of water viscosity and entrapment of food sources.

[2] The dose at which it has been experimentally found that 50% of test subjects die (lethal dose). This is widely used as a toxicity metric. The equivalent in aquatic environments is the lethal concentration, LC_{50}. Other metrics commonly used include the effective concentration (EC_{50}) and no-observable-effects level (NOEL).
[3] A small aquatic crustacean, commonly used as a model organism in ecotoxicology.
[4] A different aquatic crustacean.

Exposure

The exposure score was determined based on biodegradability and bioaccumulation (Table A1). ASDEI is not expected to biodegrade readily but biodegradation has been observed experimentally, particularly under anaerobic conditions. This is reflected in the reported soil half-life of 2000 days. Bioaccumulation is also not expected, due to the physical properties of the product and this is supported by the low reported octanol-water partition coefficient (Table A1).

Considering the open environment in which the product is applied, there is a risk of discharge to aquatic environments. The toxicity to aquatic organisms is low but chronic effects are not well known. ASDEI may accumulate in these environments due to its affinity for soil and suspended particles but is likely to settle to the bottom of receiving waters, and is therefore not expected to undergo long-range transport in the environment. Soil adsorption (and desorption) coefficients were not available but ASDEI does not readily dissociate from the soil matrix. Similar products are used to increase water retention in soils and repeated additions over time could lead to high surface concentrations, potentially reducing the capacity of local waterways to effectively drain the surrounding area during rainfall. Landcare Research[5] is currently undertaking testing on behalf of Pyper Vision into the medium to long term impact of this effect. Their report will be available Q2 2023 but findings to date have shown no statistically significant difference in soil infiltration before and after application.

Emerging Concern

The emerging concern score was higher for ASDEI than for any of the other chemicals in the analysis, suggesting that research interest has been relatively high, and more information on the product is likely to become available over time.

Conclusions

The results of the analysis suggest that the risks to human health are minimal. Acute (short term) aquatic effects are also minimal but accumulation of ASDEI waterways may have chronic (long term) effects on crustaceans due to some inhibition of access to food.

[5] Manaaki Whenua – Landcare Research is a New Zealand Crown Research Institute responsible for the "Science for our land and our future".

There is low potential for ASDEI to bioaccumulate but low degradability contributed to a high exposure score. Environmental accumulation is unlikely to present a hazard to human health but may impact on the transport of water in the vicinity of the application area.

Appendix

Table A1. Parameter values for ASDEI.

Parameter	Value
Toxicity	
Acute Aquatic Toxicity EC_{50}, *Daphnia* sp., (48hr test)	152 mg/L
Acute Aquatic Toxicity LC_{50}, freshwater fish (96hr test)	180 mg/L
Acute Dermal Toxicity (Mammal, LD_{50})	10000 mg/kg
Acute Mammalian Toxicity (Oral) GHS Classification	4
Acute Oral Toxicity (Mammal, LD_{50})	4000 mg/kg bw
Chronic Toxicity (rat) (oral) NOEL	500 mg/(kg bw)/d
Exposure	
Degradation in Soil DT_{50}	2000 days
n-Octanol/Water Partition Coefficient (Log K_{ow})	-0.67
Readily Biodegradable	No
Emerging Concern	
Growth rate "environmental studies"/total research (T&F, last 5 years)	8
Growth rate "toxicology"/total research (T&F, last 5 years)	8
Total "environmental studies" research (Taylor & Francis, last 5 years)	3472
Total "toxicology" research (Taylor & Francis, last 5 years)	1702