A novel adsorption product for the treatment of per- and poly-fluorinated alkyl substances (PFAS) in wastewater from airport fire-training grounds

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Introduction

A government airport authority in Australia is investigating options to mitigate the environmental risks associated with residual Per- and Polyfluorinated Alkyl Substances (PFAS) detected at several airport sites, particularly in the form of Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA).

A lab-scale trial was performed to assess two adsorption products marketed by Ziltek, RemBind™ and RemBind Plus™, as a treatment solution specifically targeting PFASs at levels typically found in wastewater produced by aviation rescue fire fighting training activities (Figure 1).

Figure 1: A Hot Fire Training Ground

Methods

Trials were conducted using wastewater from a Hot Fire Training Ground. This stock was not pre-filtered and contained some residual hydrocarbons. For each experiment, RemBind or RemBind Plus was dosed into prepared wastewater aliquots (2 litre HDPE beakers, see Figure 2), stirred for 2 hours, then filtered and sent to an accredited laboratory for analysis of PFOS, PFOA and 18 other PFAS compounds as listed in Table 1.

Variables tested include the dose rate of the RemBind products, contaminant concentration (via dilution) and varying amounts of Jet A-1 fuel spiked into the raw wastewater. Appropriate controls were included to ensure that PFAS compounds were not generated by, or adsorbed to, the laboratory equipment.

Results and Discussion

The equilibrium concentrations (i.e. the residual solute concentrations after the RemBind / Plus dose) were fitted to Freundlich-model adsorption isotherms. The PFOS and PFOA isotherms for RemBind treatments are shown in Figure 3.

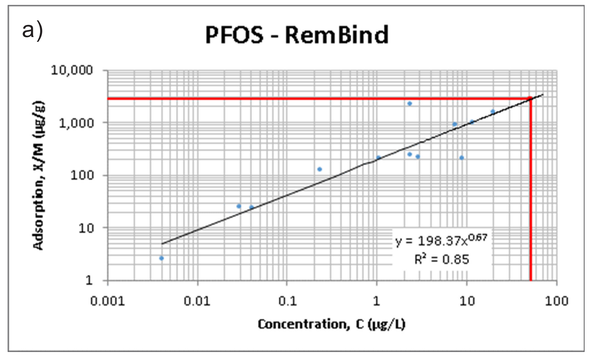
RemBind showed an adsorption capacity of 2,560 µg/g for PFOS and 6.76 µg/g for PFOA. There was little difference in adsorption capacity between RemBind and RemBind Plus.

The adsorption capacity suggests that around 20 kg of RemBind would be required to reduce PFOS levels in a 20kL tank of the raw wastewater to below 0.3µg/L, the safe drinking water limit proposed by the Minnesota Department of Health.

Table 1 shows the dose rate of RemBind required to reduce the concentrations of the various PFASs in the wastewater to below 0.3 µg/L. Further work is required to determine the mechanisms of action of RemBind on these compounds which have diverse chemistries.

Gross hydrocarbons were shown to reduce the adsorption of PFASs onto the RemBind products. It was recommended that any use of RemBind in a PFAS treatment system should include a pre-treatment stage to reduce total recoverable hydrocarbons to levels less than 15 mg/L.

Figure 2: RemBind treatments were stirred in 2 litre flasks for up to 2 hours



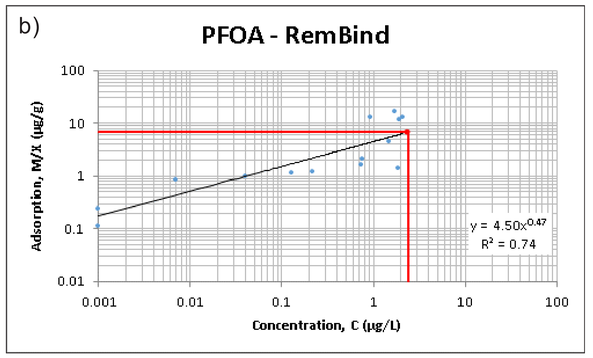


Figure 3: RemBind isotherms for a) PFOS and b) PFOA

Conclusions

RemBind products were very effective in removing PFAS compounds from a raw wastewater from a Hot Fire Training Ground at addition rates of less than 0.1% by weight.

These results pave the way for using RemBind products in field-scale wastewater treatment plants to reduce disposal costs. Pre-treatment of wastewater to remove gross hydrocarbons should be considered as part of scale-up.

Another advantage of the RemBind products is that they could be deployed for emergency situations using *in-situ* equipment and a simple pump and filtration rig.

Table 1: RemBind dose rates required to reduce the concentration of various PFAS compounds to <0.3 µg/L

PFAS compound	Starting concentration in wastewater (µg/L)	RemBind dose (g/L) required to reduce PFAS concentration to <0.3 µg/L
PFOS	51.7	1
PFOA	2.05	2
6:2 FtS	0.84	1
8:2 FtS	12.4	1
PFOSA	0.243	0.04
N-Me-FOSA	<0.10	N/A
N-Et-FOSA	<0.020	N/A
N-Me-FOSE	<0.1	N/A
N-Et-FOSE	<0.1	N/A
PFBS	0.852	10
PFHxS	9.82	2
PFDcS	<0.020	N/A
PFHxA	3.27	10
PFHpA	1.02	10
PFNA	2.13	1
PFDcA	0.676	0.04
PFUnA	0.037	0.04
PFDoA	<0.020	N/A
PFTriA	<0.020	N/A
PFTeA	<0.10	N/A

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