RemBind®

Product Overview

Tersus Environmental

For every zone of your plume, we've got you covered!

Chemical Fixation of Organic & Inorganic Contaminants

(US Patent 8,940,958)

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RemBind®

Features and Benefits

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RemBind® *(US Patent 8,940,958)*, a powdered reagent manufactured by Ziltek Pty Ltd that binds up and immobilizes contaminants in soil. *RemBind*® is typically added at less than 5% by weight using conventional soil blending equipment. Binding occurs within 24hrs.

The *RemBind*® family of products are designed to treat a range of organic contaminants including TPH, PAH, PFOS, PCBs, PCPs, and various pesticides. It can also immobilize heavy metals such as arsenic, chromium and mercury.

RemBind® is the leading adsorbent material for treatment of PFAS-impacted soils. With a proven track record of successfully treating thousands of tons, *RemBind*® is a rapid, easy and cost-effective remediation strategy for mitigating the impact of PFAS-contaminated soil on the environment.

In support of this technology, Tersus performs laboratory treatability studies and provides post-treatment validation testing and reporting where required.

Benefits

- Avoid landfill costs by leaving soil on-site
- Fast, low risk alternative costly remediation
- Reclassify soil to a cheaper disposal category

Features

- High performance – meets stringent global standards
- Product inventory located in Chicago for short delivery times to most cities
- Easy to apply using conventional equipment
- Developed in collaboration with Australia's national science agency, Commonwealth Scientific and Industrial Research Organization (CSIRO)

Applications

- Contaminated soil treatment
- Odor control
- Wastewater treatment
- Sediment remediation

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Frequently Asked Questions

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What is *Rembind*®?

RemBind® is a proprietary mix of activated carbon, aluminum hydroxide and other adsorption agents. Its structure has a large surface area with mixed charges that bind chemical contaminants via adsorption, ionic bonding and other physical and chemical interactions. *RemBind*® stops contaminant leaching from soils, mitigating health and environmental risks.

What contaminants can *RemBind*® immobilize?

RemBind® will immobilize any organic contaminant that activated carbon will immobilize. These include PCBs, PAHs, TPH, PCP, PFASs, etc. In fact, the product binds certain shorter chain organic molecules with a higher affinity than activated carbon (i.e., 6:2 FtS – Fluorotelomer sulfonate - a precursor chemical that can transform into PFOA). *RemBind*® can immobilize amphoteric metals such as chromium and arsenic.

Will *RemBind*® work for my project? How much do I need?

Tersus is available to evaluate the feasibility of using our technologies at your site. To take advantage of this service, complete the online form at www.tersusenv.com/support and send ancillary documentation such as conceptual site models, plume maps, groundwater elevation maps, cross sections, boring logs and groundwater biogeochemical data.

RemBind® addition rates of 2% to 10% by weight are typically adequate. Tersus performs *RemBind*® treatability and performance studies to provide an optimal site-specific mixing formulation. To undertake a study, Tersus requires approximately 25 pounds of soil and two weeks to complete. Post-treatment validation testing and reporting is also available upon request.

Which *RemBind*® grade is adequate for my project?

Standard *RemBind*® is adequate for PAHs, TPHs and most applications. For emerging contaminants with relatively low regulatory threshold values, such as PFASs, *RemBind*® PLUS might be more suitable. Our treatability study will help determine the right product and concentration for your situation.

How do I add the product in the field?

Mix *RemBind*® thoroughly with soil at the pre-determined addition rate. A loader or backhoe could be used for small projects. Purpose-built soil blending equipment can process 350 cubic yards of soil per day. Add enough water during the process to achieve an "apple crumble" consistency (water volumes are estimated after treatability study results). 48 hours should be allocated to allow the mixture with a roughly 40% moisture to stabilize before collecting validation samples.

What is the availability of the product?

RemBind® and *RemBind*® PLUS are available in 850 Kg and 700 Kg Super Sacks, respectively. Expect standard shipping times from Chicago. Delivery times for orders over two truckloads are available upon request.

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Why wouldn't I use activated carbon?

While activated carbon will bind a range of organic contaminants, it does not bind some shorter chain compounds with the same affinity as *RemBind*® does. Addressing some of these smaller compounds (i.e., perfluorinated compounds, 6:2 FtS, etc.) can be critical from a regulatory perspective due to their high mobility in groundwater and because they may be precursors to other regulated compounds.

How long does the binding last?

Soil stabilization using *RemBind*® can pass the most stringent leachability test used by the EPA. This test follows the Multiple Extraction Procedure (EPA Method 1320), which simulates 1,000 years of acid rain in an improperly designed sanitary landfill.

What are the mechanisms for binding?

The activated carbon component binds to organic compounds through adsorption, where the organic molecules adhere to the surface of the activated carbon through physical attraction forces. The exact mechanism of action depends on the type of molecule in question, but the adsorption process mainly involves van der Waals forces, covalent bonding and/or electrostatic attraction. Due to its relatively large internal surface area, activated carbon is the most widely used adsorbent in the world.

The aluminum hydroxide component of *RemBind*® is in an amorphous form which means it lacks a rigid crystalline structure. This results in a charged and relatively large surface area, rendering it suitable for binding a range of compounds, particularly amphoteric metals.

How would a *RemBind*® treatment impact aluminum content in soils?

Aluminum content might increase in soils by less than 1% after mixing with *RemBind*®, but these levels are not considered toxic. There will be insignificant leaching of aluminum at pH levels within 4-7. Although some jurisdictions may have aluminum thresholds, these are relatively high.

Can *RemBind*® treat soils with both organic and inorganic co-contaminants, such as heavy metals?

Specific amendments can be added to *RemBind*® to tailor a solution for many constituents of concern. For example, to treat lead, a phosphate-based amendment is added to *RemBind*® during manufacturing.

Does *RemBind*® also treat water?

RemBind® can effectively remove contaminants in water using pump-and-treat systems, bed filters, slurry reactors or permeable reactive barriers. *RemBind*® is particularly effective in removing PFASs from water.

RemBind®

Case Study

Firefighting Foam Contaminants (PFOS & PFOA)

RemBind® Treats Firefighting Foam Contaminants

Project Highlights

- Study demonstrated that *RemBind*® is an effective amendment to treat firefighting foam contaminants.
- Study demonstrated that *RemBind*® PLUS reduced PFOS leachability by >99.2% to below the Minnesota drinking water guidelines of 0.3µg/L.

Problem Definition

Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) are man-made chemicals that are extremely persistent in the environment. In 2009, PFOS was listed as a chemical of concern by the Stockholm Convention on persistent organic pollutants.

These chemicals are common in Aqueous Film Forming Foams (AFFF) used for firefighting and their manufacture has been restricted or banned in several countries.

Solution

Bench-scale testing was performed on behalf of an airport authority to validate the effectiveness of *RemBind*® and *RemBind*® PLUS to treat Aqueous Film Forming Foam (AFFF) contaminants in soil which include PFOS. The laboratory treatability study was independently supervised and audited by the environmental consulting company SEMF. This included sealing sample containers, doorways and fume cupboards at the end of each day to maintain integrity of the process.

Methodology

PFOS contaminated soil was collected from two different commercial airport sites in Australia and sent to Ziltek's laboratories in South Australia for processing (designated Soil 1 and 2).

Soils were air-dried, thoroughly mixed and screened in preparation for the treatment with *RemBind*®, exclusively distributed in North America by Tersus Environmental. *RemBind*® or *RemBind*® PLUS was added to the soils at various rates and, after moisture adjustment, treatments were left to cure for 48 hours.

Treated samples (and untreated controls) were sent to a commercial NATA-accredited laboratory for leachability testing using ASLP (Australian Standard Leaching Procedure (ASLP), based on US EPA Method 1311). Selected samples were subjected to the more rigorous Multiple Extraction Procedure (MEP; US EPA Method 1320) to test for longevity of binding.

Notable Results

Treatability testing results indicate that PFOS was reduced by more than 98.5% for soil from both sites. PFOA reductions followed a similar trend. For both soils, *RemBind*® PLUS reduced PFOS leachability to below the stringent Minnesota Department of Health drinking water guidelines of 0.3µg/L.

MEP results show that Soil 1 treated with 5% *RemBind*® PLUS passed the stringent MEP test which simulates 1,000 years of acid rain in an improperly designed sanitary landfill. A summary of the results is presented in Tables 1 to 3 below.

Table 1: Leachability Reduction of PFOS & PFOA for Soil 1

Site 1	ASLP Analysis			
	PFOS µg/L	%	PFOA µg/L	%
Untreated Soil	34.15	-	0.65	-
RemBind®	0.50	98.5	0.04	93.8
RemBind® PLUS	0.29	99.2	<0.02	>96.9

Table 2: Leachability reduction of PFOS & PFOA for Soil 2

Site 2	ASLP Analysis			
	PFOS µg/L	%	PFOA µg/L	%
Untreated Soil	376	-	5.51	-
RemBind®	1.76	99.5	0.27	95.1
RemBind® PLUS	0.10	99.9	<0.02	>99.6

Table 3: Multiple Extraction Procedure results for Soil 1 treated with *RemBind*® PLUS

Leach	EP	1	2	3	4	5	6	8	9
PFOS µg/L	0.04	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Conclusions

Soils amended with *RemBind*® PLUS reduced PFOS leachability by >99.2% to below the Minnesota drinking water guidelines of 0.3µg/L and that this binding was stable long term as determined by the most stringent soil leachability test available (US EPA Method 1320).

RemBind®

Case Study

Comparing *RemBind*® & GAC Adsorption of PFASs

RemBind® Outperforms GAC in Adsorption of Dissolved Per and Poly-fluorinated Substances in Water

Sensatec GmbH, an independent laboratory based in Germany, conducted column studies to compare the ability of *RemBind*® PLUS and granular activated carbon to remove PFASs from groundwater.

Methodology

Sensatec packed a column with a mixture of 10% quartz sand and 90% *RemBind*® PLUS by weight. A second column contained GAC. Applying sodium chloride as a tracer, Sensatec determined hydraulic breakthrough rates and the column pore volumes. Thereafter, Sensatec ran a water solution with a total PFAS concentration of 1.85 mg/L (510 µg/L PFOS) through the columns with continuous flow to determine breakthrough rates. Sensatec collected samples from the column outlet at the following pore volume exchanges: 1, 5, 10, 20, 30, 50, and 100. Analytes included perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), potassium perfluorobutane sulfonate (PFBS) and perfluorobutyric acid (PFBA).

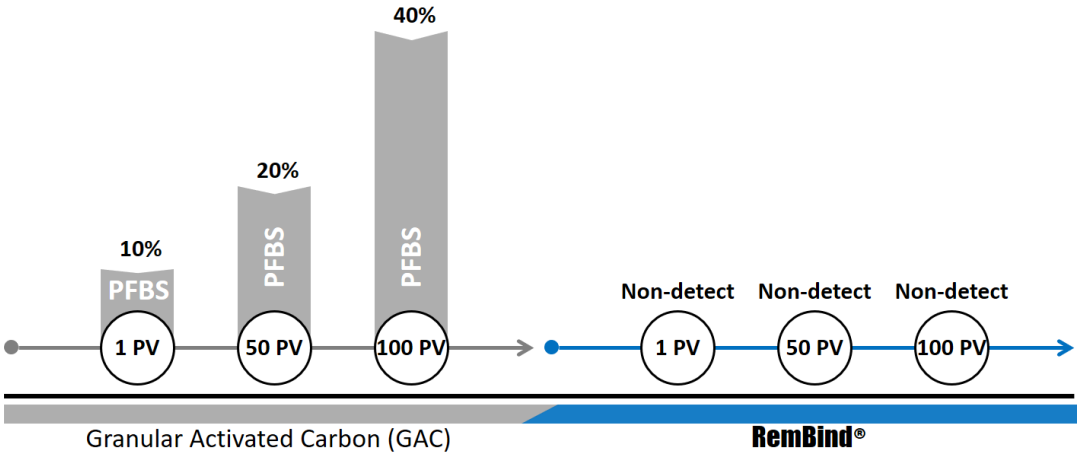
Results

The tracer study determined that a flow rate of 3.1 mL per minute would exchange a pore volume at 54 minutes. Results in figure below shows that there was minimal breakthrough of all tested compounds after 100 pore volumes had passed through the *RemBind*® PLUS column. The GAC column had breakthrough of the smaller PFAS compounds, PFBS and PFBA, after 1 pore volume.

Conclusion

The adsorption capacity of *RemBind*® PLUS is vastly superior to that of GAC for the smaller chain substances such as PFBA and PFBS. This is likely due to the presence of the non-carbon components of *RemBind*® PLUS creating unique physical chemical interactions with the smaller chain PFAS compounds.

Breakthrough results for potassium perfluorobutane sulfonate (PFBS)



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Case Study

Chemical Fixation of PAH-Impacted Soils at a MGP Site

RemBind® Treats PAH-Impacted Soils

Project Highlights

- Treatment of 2000 tons of PAH impacted soils with 5% *RemBind®.*
- Treated soils passed the Multiple Extraction Procedure (MEP) test that simulates 1000 years of acid rain in an unlined sanitary landfill.
- Project selected for the 2011 Civil Contractors Federation Earth Award.

Problem Definition

A former MGP site located at Mead St, Birkenhead in South Australia, contained approximately 2,000 tons of PAH-contaminated soils that required off-site treatment and disposal.

Methodology

The treatment process involved adding *RemBind*® and a solidification agent at 5% by weight. A single pass reduced the leachability of the Polycyclic aromatic hydrocarbons and Benzo(a)pyrene to below the landfill criteria for Low Level Contaminated Waste (LLCW) to allow the safe disposal of the treated soil.

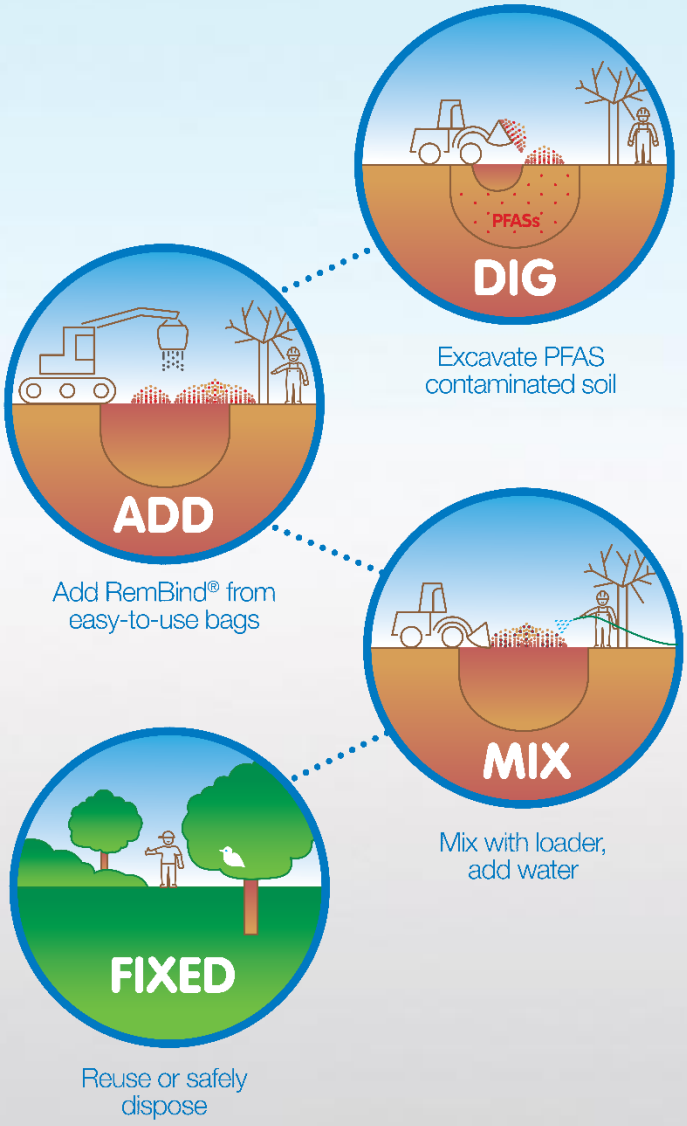
Notable Results

Chemical Constituent	Leachability (mg/L TCLP)	
	Before Treatment	After Treatment (5% w/w)
B(a)P	0.0083	0.0013
Total PAH	4.435	0.0351

The treated soil also passed the MEP which is recognized as one of the world's most stringent soil leachability test. The test simulates the worst case leaching scenario - the leaching that a waste will undergo from repetitive precipitation of acid rain on an improperly designed sanitary landfill. The repetitive extractions are design reveal the highest concentration of each constituent that is likely to leach in a natural environment. While the TCLP and SPLP were designed, to simulate 100 years' exposure in a landfill, the more stringent MEP was designed to simulate 1,000 years in a landfill.

RemBind®

The proven solution for PFASs in soil



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