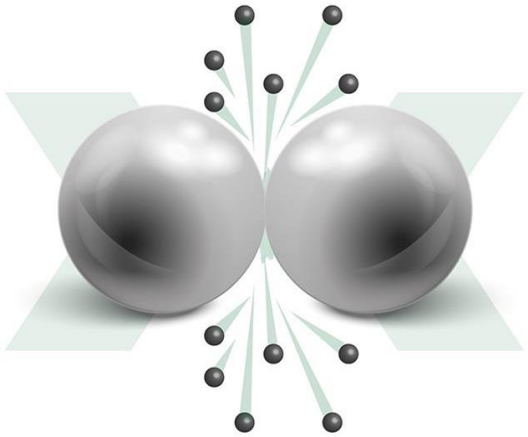

Advancing Scale-Up of Mechanochemical Destruction for PFAS-Impacted Soils: Insights from a US Department of Defense Project

WasteMINZ-ALGA Conference 2026

Solution Focused

Technology Supplier

Edl

Technology Platform

- Per- & Polyfluoroalkyl Substances (PFAS)
- Persistent Organic Pollutants (POPs)
- Asbestos
- Materials Processing (e-waste, shells, pozzolans)
- Nuclear Waste
- Illicit Drugs and Pharmaceuticals

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

VEOLIA

UNDP

GSI ENVIRONMENTAL

eurofins

New Zealand DEFENCE FORCE
Te Ope Kātua O Aotearoa

Edl

PFAS Challenges

PFAS-Laden Matrices

Contaminated Soils

- Complex impacted soil challenges.

Product Stockpiles

- AFFF and other obsolete products.

Concrete

- Fire-fighting training pads.

Spent Sorbents

- GAC, resins, and other sorbents.

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Technology Capabilities

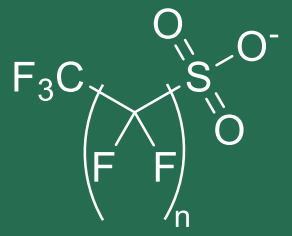
Mechanochemical Destruction (MCD)

Hazardous Waste Treatment

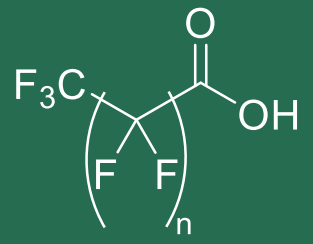
- Mechanochemistry based solution.
- Green solution for waste stockpiles.
- PFAS, POPs, problematic organics, asbestos.

Waste-to-Value

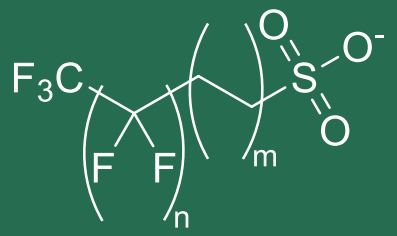
- Convert various waste into value products.
- Create fine and ultrafine powders.



Perfluorosulfonic acids



Perfluorocarboxylic acids



Fluorotelomer sulfonates

And more

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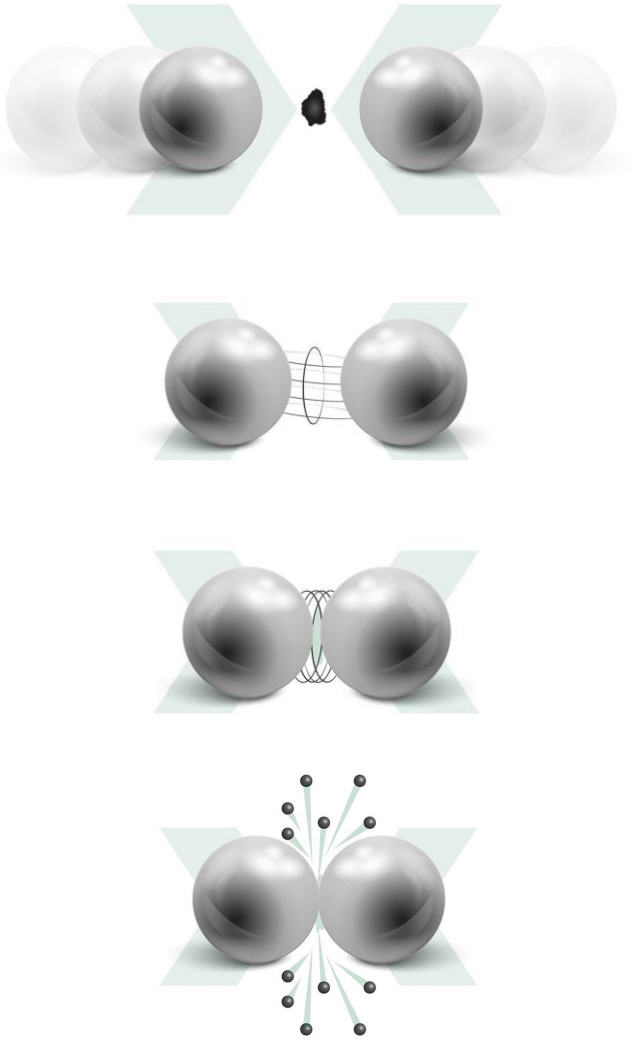
The Science

Collision Profile



High Velocity Impact

Elastic Deformations

Plastic Deformations

Fracture

Basic Technology Concepts

- Ball bearings in MCD reactors collide.
- Particles are subject to intense conditions.
- Optimising mechanical activation.

Key advantages

✓ No additives or solvents

✓ Low temperature and pressure

✓ Inert by-products

✓ Simple and scalable operation

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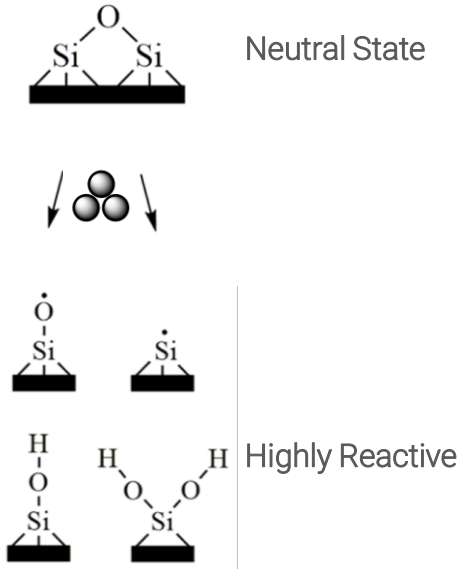
Fundamentals of PFAS Destruction by MCD

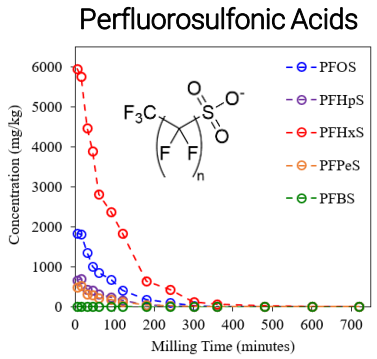
PFAS + Reactive Surfaces → Intermediates → Mineralised By-Products

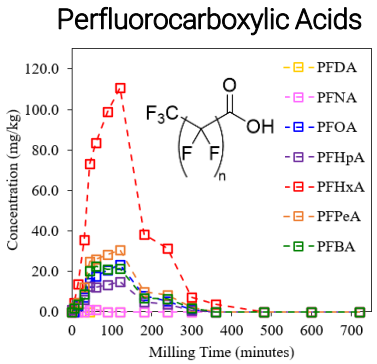


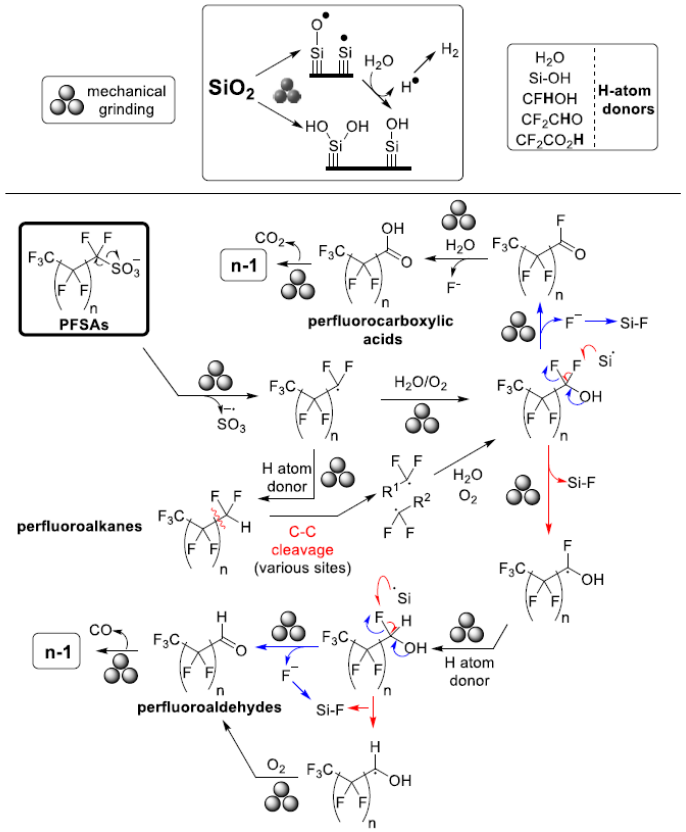
Procedure

PFAS Standard(s)
~0.05 g

Quartz Sand
~5.00 g







Gobindlal et al. The Mechanism of Surface-Radical Generation and Amorphization of Crystalline Quartz Sand upon Mechanochemical Grinding. *J. Phys. Chem C, 2021*.
Gobindlal et al. Solvent-Free, Ambient Temperature and Pressure Destruction of Perfluorosulfonic Acids under Mechanochemical Conditions: Degradation Intermediates and Fluorine Fate. *Environ. Sci. Technol., 2023*.

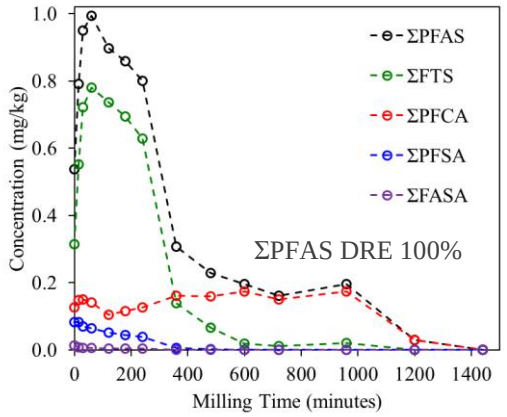
Real-World Challenges

Contaminated Soil

Authentic sample derived from a New Zealand Defence Force site.

Incredibly complex PFAS profile due to decades of foam use.

Ball milling of PFAS-impacted soil leads to a DRE for PFAS of 100% and an inert end-product.

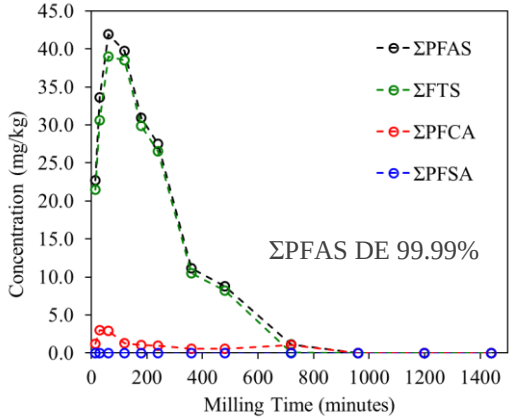


AFFF Concentrate

Obsolete foam concentrates are a major liability issue.

5%-10% fluorosurfactants in foams.

Ball milling of AFFFs on suitable matrix bed proved highly effective, with a DRE for PFAS of 99.99%.



Gobindlal et al. Mechanochemical Destruction of Per- and Polyfluoroalkyl Substances in Aqueous Film-Forming Foams and Contaminated Soil. *Environ. Sci.: Adv., 2023.*

US DoD Project

2024 – 2026

Environmental Security Technology Certification Program (ESTCP).

2.5-year programme focused on scaling up MCD.

All work conducted in NZ.

- University of Auckland
- US EPA
- GSI Environmental, Inc. USA
- Eurofins USA & Aus

Evaluation of Ball Milling as a Destruction Technique for PFAS in Impacted Soil

Expected Outcomes

- Scalability of ball milling technology established for first time (PFAS).

- Technology optimisation to inform implementation.

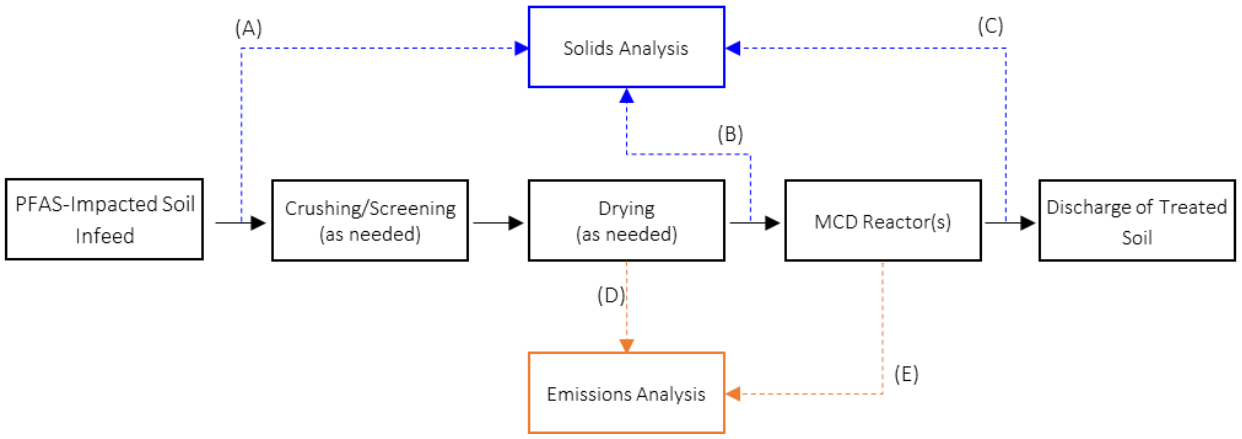
- In depth feasibility study (technical and commercial).

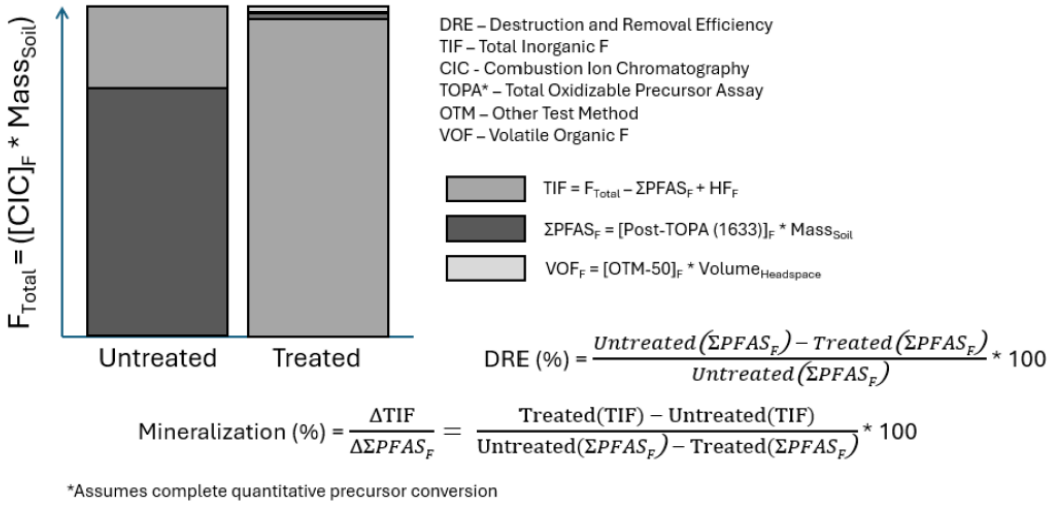
- On site demonstration in USA.

US DoD Project Performance Objectives

Evaluation of performance (quantitative and qualitative) taking place across three major technical and commercial tasks:

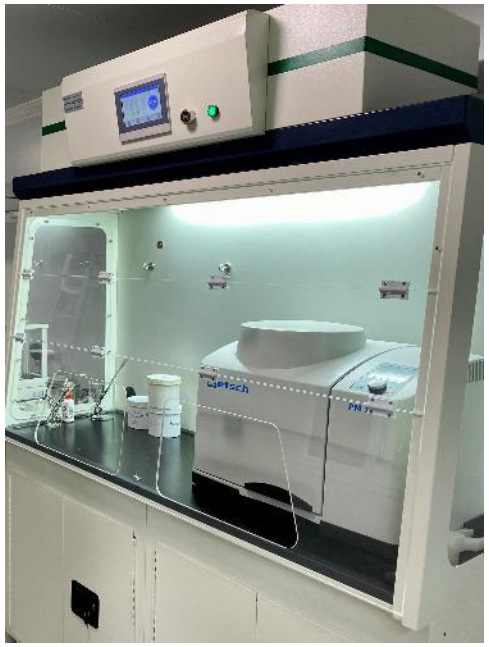
1. Bench-Scale Treatability Study. (*Complete*).
2. Batch Pilot-Scale MCD of Contaminated Soil. (*Underway*).
3. Continuous Flow Pilot-Scale MCD of Contaminated Soil. (*Underway*).





Solution Roadmap: MCD of PFAS

Benchtop



Efficacy, kinetics, 50 g.
Technology capability.

Intermediate

Scalability, 10-20 kg.
Efficacy.

Demonstration

Optimisation at continuous flow, 0.5-1.0 t/h.

Deployable System

Performance Assessment: Treatability Study

- Bench-scale treatability trials successfully completed.
- Two discrete PFAS-impacted soils and one spent sorbent evaluated.
- Achieved target performance criteria across all materials. 99-100% DRE for total target PFAS.

Soil 1 - Defence Site

DRE = 100%

	PFSA (µg/kg)					PFCA (µg/kg)						FTS (µg/kg)		FTCA (µg/kg)	
	PFBS C4	**PFPeS C5**	**PFHxS C6**	**PFHpS C7**	**PFOS C8**	**PFBA C4**	**PFPeA C5**	**PFHxA C6**	**PFHpA C7**	**PFOA C8**	**PFNA C9**	**6:2 FTS C6**	**8:2 FTS C8**	**3:3 FTCA C3**	**7:3 FTCA C7**
Untreated	0.06	0.09	1.17	0.10	55.00	18.00	72.00	35.33	19.00	24.67	23.00	243.33	360.00	120.00	76.33
Treated	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ

Soil 2 - Airport Site

DRE = 99%

	PFSA (µg/kg)					PFCA (µg/kg)						FTS (µg/kg)		Other (µg/kg)	
	PFBS C4	**PFPeS C5**	**PFHxS C6**	**PFHpS C7**	**PFOS C8**	**PFBA C4**	**PFPeA C5**	**PFHxA C6**	**PFHpA C7**	**PFOA C8**	**PFNA C9**	**6:2 FTS C6**	**8:2 FTS C8**	**5:3 FTCA C5**	**PFOSA C8**
Untreated	0.18	1.43	246.67	< LOD / < LOQ	3633.33	1.93	7.20	44.00	1.73	14.00	2.53	0.28	1.10	5.90	176.67
Treated	< LOD / < LOQ	< LOD / < LOQ	7.30	0.02	35.00	2.95	1.30	4.40	0.48	1.25	0.07	1.00	< LOD / < LOQ	< LOD / < LOQ	0.70

Performance Assessment: Batch Pilot Trials

- Preliminary pilot-scale MCD trials conducted on PFAS-impacted soil.
- Initial total PFAS concentration was 800-1,250 µg/kg.
- Mechanochemical milling achieved significant PFAS degradation.
- Final PFAS concentrations reduced to below detection / quantification limits.

Soil 2 - Airport Site

DRE = 100%

	PFHxS C6	PFOS C8	PFNS C9	PFDS C10	PFHxA C6	PFOSA C8
Treated	80.4	617	13.6	12.0	11.7	62.5
Untreated	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ	< LOD / < LOQ

Upcoming Trials & Project Completion

Continuous pilot-scale trials scheduled to commence May-July 2026.

Trial outcomes to inform full-scale commercial implementation.

Establishing an engineered MCD solution for broader PFAS applications globally.

Baseline capability being developed for treatment of other PFAS-laden solid wastes.

CAPEX and OPEX assessments underway to support commercial feasibility evaluation.

Demonstration Plant – Ready to Go

Operational Plants

Next Steps

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