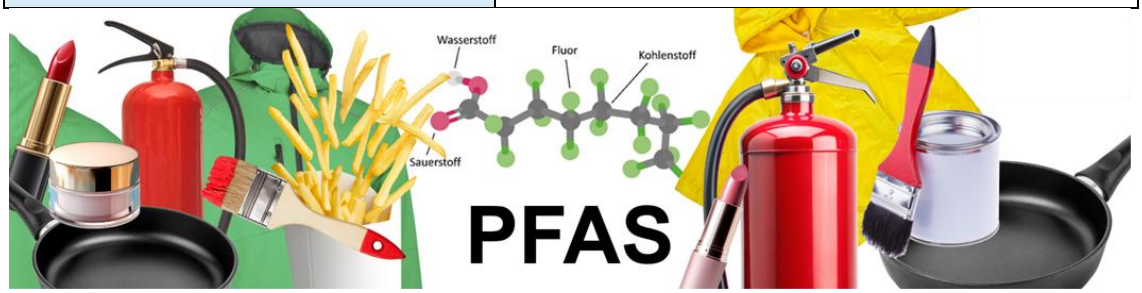
PFAS removal, concentration, destruction and market opportunities

Scope	**Origins of PFAS, affected effluents, capture/concentration/destruction trains, sizing for 1,000 m^3/day, CAPEX/OPEX, leaders, and Europe/USA market opportunities.**
Recommended concept	Primary concentration (foam fractionation or membranes) → secondary concentration by evaporator → final destruction with SCWO / hydrothermal / electrochemical solutions.



Author: Sergio Tuset tusetengineering.com

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1. Executive summary

PFAS (per- and polyfluoroalkyl substances) are a broad family of highly persistent fluorinated compounds used in fire-fighting foams, fluoropolymer production, semiconductor manufacturing, metal finishing, textiles, paper and other specialty applications. Because the C–F bond is extremely stable, the practical industrial strategy is rarely direct destruction of dilute water. The economically rational route is almost always: capture or pre-concentrate PFAS first, reduce the residual volume further, and then destroy only the final concentrated stream. For most industrial projects, the best-performing integrated concept is one of these trains: (i) foam fractionation → evaporator → destruction; (ii) RO/NF → evaporator → destruction; or (iii) IX / GAC → off-site regeneration or destruction of spent media when direct on-site destruction is not justified, iv) IX →in site regeneration (eluate) → evaporator → destruction

(*) Current destruction technologies: SCWO / hydrothermal/Electro oxidation/Incineration

2. Origin of PFAS / PFOA / PFOS and related compounds

PFAS are synthetic organofluorine chemicals developed largely from the 1940s onward. Commercial use expanded because PFAS can provide low surface energy, chemical inertness, oil and water repellence, thermal stability and surfactant behavior. Important legacy compounds include PFOS and PFOA, while newer substitutes include shorter-chain compounds and fluorinated ether species such as HFPO-DA (GenX).

- AFFF fire-fighting foams used at airports, petrochemical sites and military facilities.
- Fluoropolymer and fluorochemical manufacturing.
- Metal plating / hard chrome operations and mist suppressants.
- Semiconductor and electronics manufacture.
- Textile, leather, paper and packaging treatments.
- Landfills and wastewater systems receive PFAS-bearing waste streams.

3. Major sources of PFAS

Source / sector	Typical PFAS pattern	Concentration tendency	Treatment note
Groundwater remediation	Mixed legacy PFAS	ng/L to low µg/L	Usually capture-first; destruction only on concentrate
Landfill leachate	Mixed chain lengths, variable matrix	µg/L to mg/L	Foam fractionation and/or RO are attractive
AFFF concentrate / rinsates	Very high PFAS load	mg/L to g/L	Destruction becomes more viable
Industrial wastewater	Site-specific mixture	µg/L to mg/L	Resin, GAC, membranes or SAFF depending on matrix
RO reject / IX regenerant / foamate	Already concentrated	mg/L upward	Best candidate for evaporator + destruction

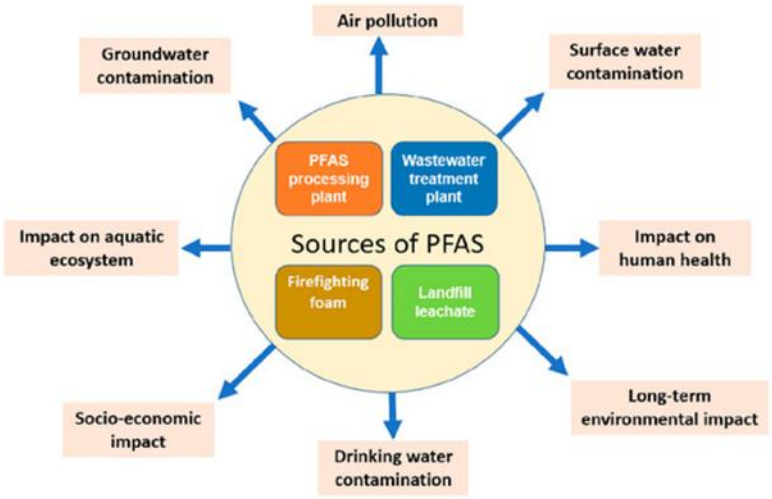

Fig 1: Sources of PFAS

4. Treatment philosophy: capture, then concentrate, then destroy

1. Primary capture / concentration: remove PFAS from the bulk flow using GAC, ion exchange, membranes, or foam fractionation.
2. Secondary concentration: further reduce the residual volume using thermal concentration, normally an evaporator applied only to the PFAS-rich sidestream.
3. Final destruction: treat the small, high-strength stream using the most effective destruction technologies, typically SCWO, hydrothermal alkaline treatment, incineration or selected electrochemical systems.

The key economic principle is that the destruction step is the most expensive part of the train. Therefore, project value depends on minimizing the volume sent to the destruction unit.

5. Primary removal / separation technologies

5.1 Granular activated carbon (GAC)

Adsorption on microporous carbon. Mature, proven and widely accepted. Strongest for longer-chain PFAS and cleaner waters. Lower competitive advantage where short-chain PFAS dominate or where NOM/TOC is high. (Fig2)

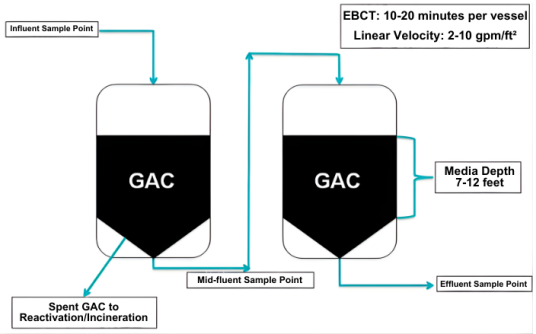

Fig 2: Granulated Activated Carbon in series filters for separation/Removal

Pros: High maturity; Straightforward permitting and operation; Good polishing step.

Cons: Spent carbon management needed; Less favorable for short-chain PFAS; Can be penalized by organics loading.

5.2 Ion exchange (IX)

Strong-base anion and specialty resins can achieve remarkably high removal and often outperform GAC for short-chain PFAS. Excellent where low finished-water targets are needed. (Fig 3)

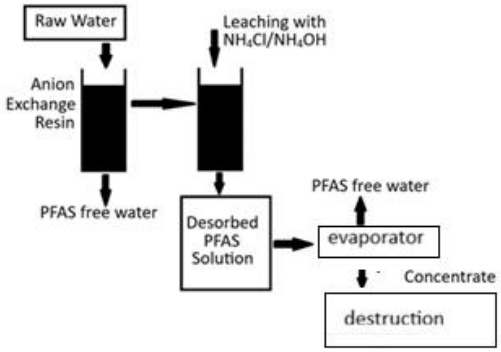

Fig 3: Ion Exchange Resin typical process for separation and concentration

Pros: High loading capacity; Reduced footprint; Often better than GAC for short-chain PFAS.

Cons: Regeneration / replacement strategy needed; Residual PFAS-bearing resin or regenerant remains.

5.3 Nanofiltration (NF) / reverse osmosis (RO)

Membranes separate PFAS very efficiently and are especially useful where broad removal, including shorter-chain compounds, is needed. The penalty is a PFAS-rich reject stream and higher pressure/pretreatment costs (Fig 4)

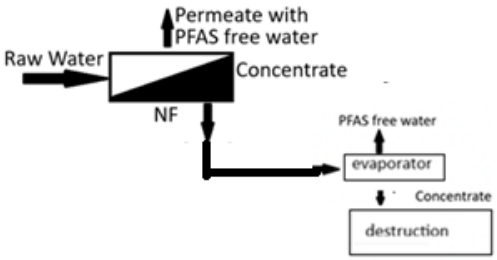

Fig 4: Nanofiltration for separation and concentration

Pros: Extremely high removal; Captures short-chain PFAS better than many adsorbents; Established industrial supply chain.

Cons: Reject stream still needs management; Fouling and scaling; accurate pretreatment.

5.4 Foam fractionation (SAFF and related systems)

Use the surfactant nature of different types of PFAS. Air bubbles create a foam phase that selectively enriches PFAS, creating a much smaller concentrate stream. Extremely attractive for leachate, remediation water and other matrices where surfactants like PFAS dominate.

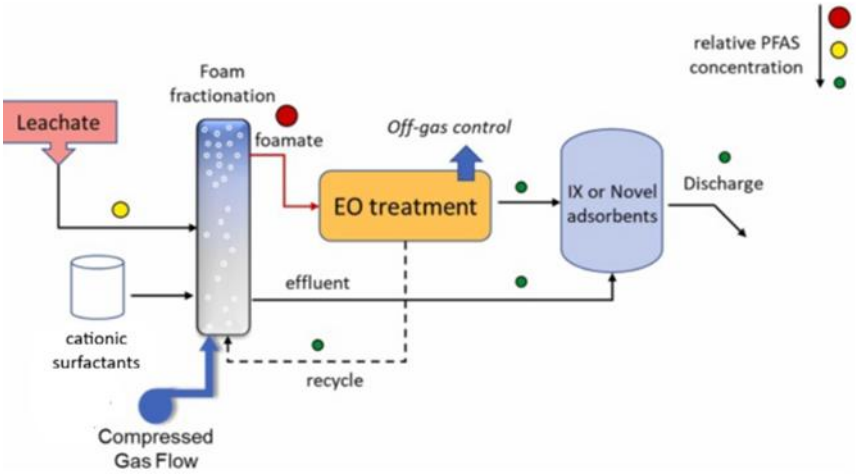

Fig 5: Foam fractionation separation and destruction

Pros: Low energy; Strong volume reduction before destruction; No large media replacement requirement.

Cons: Best performance is typically on more surface-active PFAS; Site-specific pilot work is important; Usually it needs downstream polishing or destruction.

6. Secondary concentration by evaporator

The evaporator should normally be applied to the already concentrated sidestream, not to the whole 1,000 m^3/day feed. Typical candidates are RO reject, IX regenerant, or foam fractionation concentrate. Vacuum evaporation or MVR/MVC concepts are favored because they can reduce volume by roughly 10–50× while keeping the destruction feed small enough for specialized oxidation or hydrothermal systems.

Concept stream	Illustrative flow	Typical role	Comment
Raw PFAS-bearing water	1,000 m^3/d	Bulk flow	Do not send directly to SCWO
Primary concentrate	10–50 m^3/d	After SAFF or RO/IX regeneration	Good evaporator feed
Evaporator concentrate	0.5–5 m^3/d	Final feed to destruction	Best economics for destruction

7. Final destruction technologies

7.1 Supercritical water oxidation (SCWO)

A high-temperature, high-pressure aqueous oxidation environment above the critical point of water. One of the strongest options available for destroying concentrated PFAS liquids. Best suited to small, concentrated streams due to pressure, materials and salt management requirements. (Fig 6)

Industrial relevance: Remarkably high destruction potential; commercially visible PFAS offering; strong fit after concentration.

PFAS removal, concentration, destruction and market opportunities

Supercritical Water Oxidation (SCWO) is an advanced oxidation technology that destroys PFAS (per- and poly-fluoroalkyl substances) by subjecting contaminated water to temperatures >374°C and pressures >221 bar (Fig 7) At this critical point, water becomes a fluid that oxidizes organic pollutants, breaking the strong carbon-fluorine bonds to achieve >99% destruction of PFOA/PFOS, mineralizing them into harmless compounds like carbon dioxide, water, and fluoride ions.

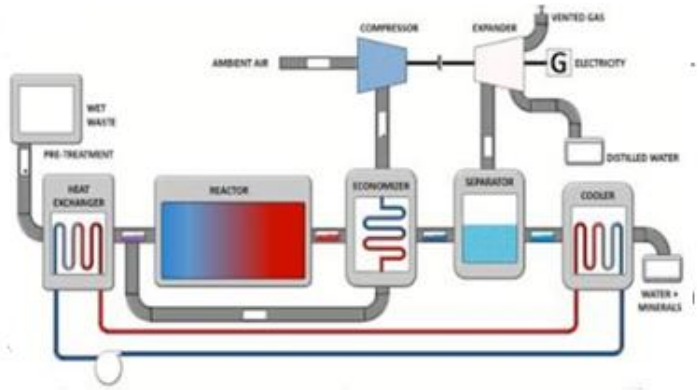

Fig 6 Super critical water oxidation process

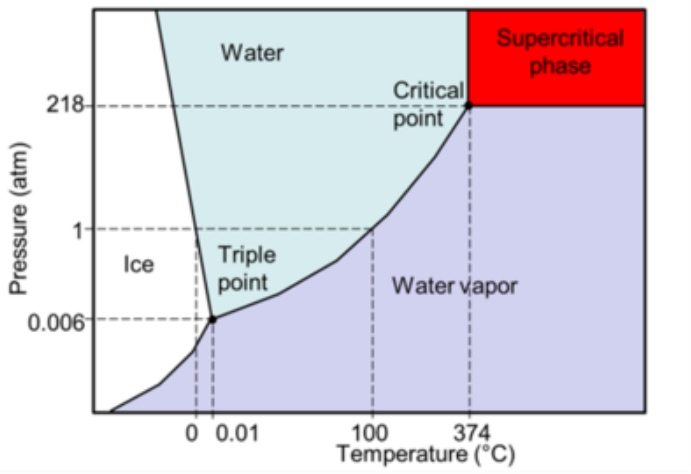

Fig 7: Pressure/Temperature graph for SCWO critical point

How SCWO Destroys PFAS

- **Supercritical State:** Water is brought above 374°C and 221 bar, where it acts as a solvent for organic materials while acting like gas, allowing oxygen to rapidly oxidize organic waste.
- **The Process:** A liquid waste stream (such as AFFF, landfill leachate, or biosolids) is mixed with an oxidant (like oxygen or air) in a pressurized reactor.
- **Molecular Breakdown:** The extreme conditions break down the persistent carbon-fluorine (C-F) bonds in PFAS, converting them to CO2, H2O, and inorganic fluorides.

Pros

- **High Efficiency:** Often removes >99.99% of PFAS compounds, reducing concentrations to below detectable levels.
- **Total Destruction:** It breaks down the molecules completely (mineralization) rather than just separating them, avoiding the need for further treatment of concentrated waste.
- **Versatility:** Capable of treating diverse PFAS waste streams, including concentrated aqueous based form and AFFF airport fire-fighting foams

Cons

- **Corrosion:** The process can produce hydrofluoric acid, requiring specialized materials to manage corrosion within the reactor.
- **Operating Costs:** High energy input for heating and pressurization makes it a high-cost option compared to conventional methods, though it offers a complete destruction solution.
- **Optimal Conditions:** While lower temperatures can break down some PFAS, studies show temperatures ≥575°C must often destroy perfluorosulfonic acids effectively.

7.2 Hydrothermal alkaline treatment (HALT / related hydrothermal routes)

Hydrothermal chemistry using alkaline conditions to break PFAS in concentrated liquids is an emerging technology, often promoted as more field-deployable or less severe than classical SCWO while still targeting permanent destruction. Results a highly effective technology used to destroy per- and polyfluoroalkyl substances (PFAS)—often referred to as "forever chemicals"—in contaminated water, soil, and industrial waste. It works by combining high temperatures, high pressure, and a strong alkaline agent (such as sodium hydroxide) to break the extremely strong carbon-fluorine bonds that make PFAS resistant to natural degradation (Fig 8)

Industrial relevance: Very good fit for concentrates, regenerants and leachate-derived side streams.

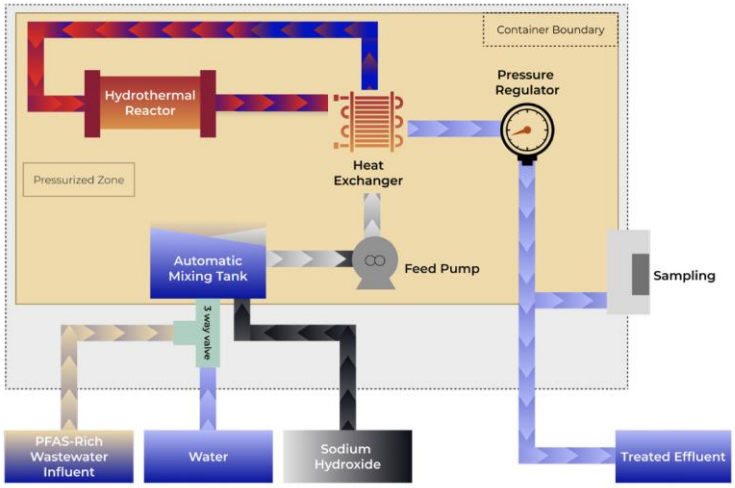

Fig 8: HALT process diagram

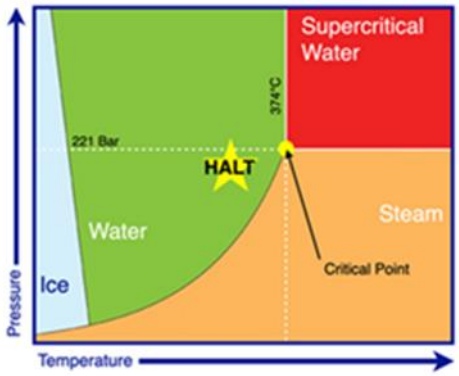

Fig 9: Pressure/Temperature graph for HALT critical point

How Alkaline Treatment (HALT) Destroys PFAS

HALT operates under subcritical water conditions—typically at temperatures of 300–350°C, pressures above 20 MPa, and a pH greater than 13. (Fig 9) The process breaks down PFAS in two main ways:]

- **Hydroxide-Driven Defluorination:** Strong alkaline conditions provide an abundance of hydroxide ions , which attack the carbon-fluorine bonds, converting them into inorganic fluoride, a much safer, non-toxic form.
- **Thermal Destruction:** High heat enables the cleavage of the carbon-sulfur bonds in recalcitrant sulfonic acids (like PFOS), allowing them to be broken down into simpler, less toxic compounds.

Pros of HALT

- **High Destruction Efficiency:** Studies show HALT can destroy and defluorinate over 99% of a wide range of PFAS compounds, including long-chain and short-chain types.
- **Mineralization:** It breaks down PFAS into harmless, inorganic components (like fluoride, formate, carbonate, and oxalate) rather than just transferring them from one material to another.
- **Treats Complex Waste:** It is effective for concentrated waste streams, including firefighting foams (AFFF), wastewater sludge, spent ion exchange resins, and contaminated soil.
- **No Air Emissions:** Commercial HALT systems are designed to operate as closed loops, meaning they do not produce toxic air emissions.

Cons of HALT

- High energy and operational cost: as hydrothermal process requiring elevated temperatures and costly to operate, often limiting its application to concentrated waste streams rather large streams, low concentration water treatment.
- Operation complexity: HALT needs high pressure/elevated temperature (subcritical water) reactors, which complicate engineering, maintenance, and scale up.
- Corrosion and Chemical handling: using high concentration of caustic agents (NaOH) ai elevated temperatures and pressures poses corrosion hazards, needs to use special alloys and rigorous safety protocols.
- Limited field verification: several studies are still in laboratory or pilot stage, not proven long term stability and economic viability of scaling up to treat complex, real-world wastewater have not yet been fully validated

Common Applications

- **On-site Remediation:** Used to treat firefighting pit water and contaminated groundwater.
- **Regenerating Adsorbents:** HALT can be used to clean contaminated activated carbon (GAC) on-site, allowing it to be reused, which is more cost-effective than disposal.
- **Soil Treatment:** It can destroy PFAS absorbed into soil and sludge matrices.

While several types of PFAS, such as perfluoroalkyl carboxylic acids (PFCAs), can be degraded at lower temperatures (e.g., >200°C), more resistant sulfonic acids (PFSAs) usually require higher temperatures and higher pH levels of the full HALT process.

7.3 Electrochemical oxidation

Electro-oxidation (EO) is a highly promising electrochemical technology for the full destruction of per- and polyfluoroalkyl substances (PFAS) in water. Electro-oxidation uses electric current and specialized anodes to degrade these "forever chemicals" into harmless substances, including fluoride ions and carbon dioxide. Particularly interesting for modular, on-site deployment, though economics and performance depend strongly on matrix, conductivity and concentration.

Industrial relevance: Useful niche choice when the final stream is modest in flow and compatible with the cell design.

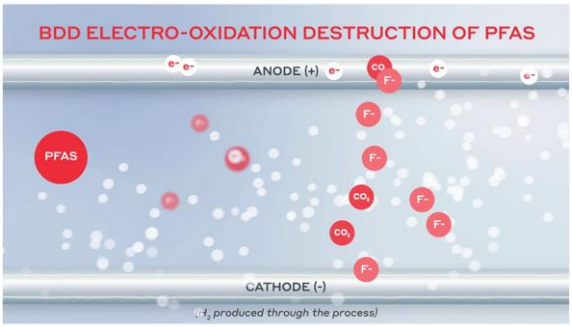

Fig 10: Electroxidation destruction explanation diagram

How Electro-oxidation Destroys PFAS

- **Direct Oxidation:** PFAS compounds in the water make contact with a positively charged anode (usually Boron-Doped Diamond, or BDD). A high anodic potential allows direct electron transfer, breaking the strong carbon-fluorine (C-F) bonds on the electrode surface.
- **Indirect Oxidation:** The anode also produces reactive oxidizing agents, specifically hydroxyl radicals , ozone, and potentially reactive chlorine species (if chloride is present), which attack and break down PFAS in the bulk solution.
- **"Unzipping" Mechanism:** The degradation process is often described as a chain-shortening "unzipping" mechanism (Kolbe decarboxylation or desulfonation), where the molecule is systematically broken down from a long chain into shorter, less persistent chains, eventually leading to full mineralization.

PFAS removal, concentration, destruction and market opportunities

Pros:

- **High Performance:** Studies show >99% removal for long-chain PFAS such as PFOA and PFOS.
- **Chloride Influence:** While some anodes are inhibited by chloride, BDD electrodes show that the presence of Cl^- can accelerate PFAS degradation through the synergistic effect of chlorine radicals and hydroxyl radicals.
- **Scalability:** The technology is modular and can be used on-site for treating concentrated PFAS waste, such as firefighting foam, landfill leachate, and wastewater.
- **Energy Consumption:** While it requires electricity, optimized systems can be cost-competitive compared to conventional methods when considering the total cost of removing and disposing of polluted carbon.

Cons:

- **Short-Chain PFAS:** Shorter-chain PFAS (like PFBS) are more resistant to breakdown and require longer treatment times.
- **Byproducts:** Under certain conditions, electrochemical processes can produce unintended harmful byproducts like chlorate and perchlorate.
- **Electrode Cost:** High-performance electrodes like BDD are costly, eventual poisoning can produce expensive cost for replacement.
- **Mass Transfer:** Efficiency can be limited by the speed at which PFAS molecules reach the anode surface, requiring effective mixing in the reactor.

7.4 Thermal destruction / incineration of liquids, solids or spent media.

7.4.1 Solids waste incineration

More relevant to spent carbon, resins or solids than to the bulk liquid train proposed here. It stays part of the overall PFAS management landscape but is less central for the evaporator-concentrate concept.

Industrial relevance: Important as a parallel route for residual solids and spent media.

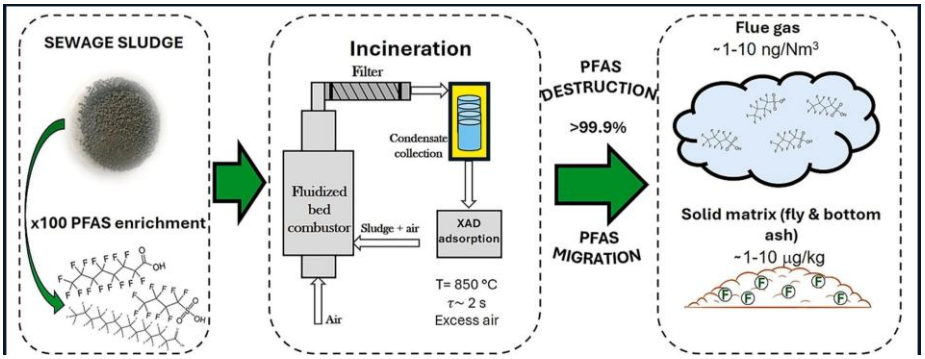

Fig 11. Thermal destruction process for waste solids

High-temperature incineration breaks down PFAS ("forever chemicals") into mineralized components like carbon dioxide, water, and inorganic fluorides, achieving destruction efficiencies over 99.99% at operating temperatures often exceeding 1,000°C–1,100°C. This process typically involves incineration of PFAS-contaminated soil, firefighting foam, and waste-activated carbon. Key requirements for complete destruction include high heat, sufficient residence time (often >2 seconds), and adequate turbulence to prevent incomplete combustion of products. (Fig 11)

Incineration Process Details

- **Optimal Conditions:** While some PFAS break down at lower temperatures, achieving high Destruction and Removal Efficiency (DRE) requires temperatures of at least 950°C to 1,100°C to destroy the strong carbon-fluorine bonds.
- **Mechanism:** Mineralization breaks the carbon-fluorine chains into harmless inorganic compounds, such as calcium fluoride, water, and carbon dioxide.
- **Waste Streams:** High-temperature incineration is used to destroy liquid, sludge, and solid materials containing high concentrations of PFAS, such as concentrated waste from water treatment systems (activated carbon, ion exchange resins).
- **Emissions Control:** Sophisticated incineration facilities, such as those permitted by the EPA or under RCRA, use advanced air pollution control systems to scrub acid gases and capture potential products of incomplete combustion (PICs).

Challenges and Considerations

- **Incomplete Combustion:** If temperatures are too low or residence times too short, PFAS may only partially decompose, leading to the creation of smaller PFAS products or dangerous PICs.
- **High Costs:** Incinerating PFAS is expensive, with costs for hazardous waste incineration significantly higher than standard municipal waste disposal.
- **Operational Control:** The effectiveness depends heavily on precise control over temperature and residence time, with some studies suggesting up to 1,400°C might be necessary for the complete breakdown of the most stable compounds.

Research indicates that high-temperature incineration stays one of the most effective methods to achieve near-total destruction of PFAS waste, provided the facilities operate under strict parameters.

7.4.2 The incineration process for liquids PFAS

- **Feed Preparation:** PFAS-laden liquids (AFFF, industrial waste) are generally injected into the incinerator along with other hazardous waste streams. (Fig.12)

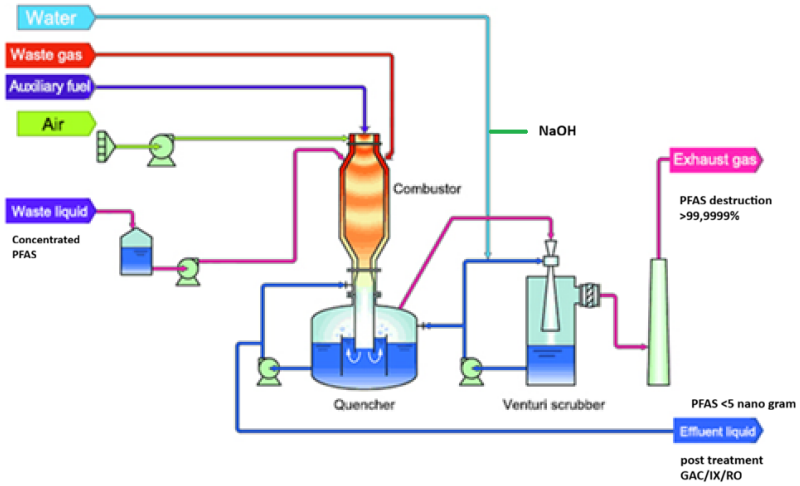

Fig 12. Liquid destruction process

- **High-Temperature Destruction:** The liquid waste enters a rotary kiln or primary chamber, then moves to a post-combustion chamber. The process requires temperatures of at least 950°C–1000°C+ and a gas residence time of at least 2 seconds to effectively break down PFAS.
- **Mineralization:** The goal is to convert the organic fluorine in PFAS into inorganic fluoride (e.g., hydrogen fluoride) and other products like CO_2 and water.
- **Flue Gas Treatment (Scrubbing):** As PFAS breaks down, it forms acidic gases (hydrogen fluoride). The flue gas is cooled and treated in a wet scrubbing system with lime or other reagents to neutralize this acid, converting it to inert residues (calcium fluoride).

Performance and Technical Requirements

- **Destruction Efficiency:** Modern incineration studies, such as those by Veolia and Clean Harbors in 2024-2025, show a Destruction and Removal Efficiency (DRE) of >99.9999% (six nines) for target PFAS substances, including PFOS, PFOA, and GenX.
- **Temperature Control:** Low-temperature incineration (<600°C–700°C) is insufficient and may merely break down long-chain PFAS into shorter-chain PFAS or release them, rather than destroying them.
- **In-Process Monitoring:** Specialized stack testing (e.g., EPA methods OTM-45 and OTM-50) is used to verify that no significant PFAS compounds or hazardous fluorinated PICs are emitted.

Residual and Environmental Considerations

- **Air Emissions:** When used at recommended elevated temperatures, air emissions are often below regulatory detection limits.
- **Liquid/Solid Residue:** Blowdown from the wet scrubber and ash from the kiln are collected and typically disposed of in hazardous waste landfills. Testing has shown that liquid residuals from this process generally contain PFAS levels below drinking water largest contaminant levels.
- **Challenges:** The process is energy-intensive and expensive, with costs often reported in the range of $300–$ 400 per ton for liquid waste.

8. Efficiency ranges and practical selection

Technology	Primary role	Indicative PFAS removal / destruction	Best use case	Main limitation
GAC	Capture	High for long-chain; moderate for short-chain	Potable / clean groundwater polishing	Spent media and shorter-chain limitations
IX	Capture	Very high in many cases	Low finished-water targets	Regeneration: eluates
RO/NF	Separation	Very high	Need broad PFAS rejection incl. short chain	Reject management
Foam fractionation	Pre-concentration	High for surface-active PFAS	Leachate, remediation, complex industrial waters	Performance varies by PFAS profile
Evaporator (vacuum)	Secondary concentration	Volume reduction rather than destruction	Sidestream minimization	corrosion / scaling design
SCWO	Destruction	Very high	Final small, high-strength liquid stream	High severity and CAPEX
HALT	Destruction	Very high potential	Concentrated liquids and regenerants	Commercial base smaller than mature separation tech
Electrochemical	Destruction	Moderate to high depending on matrix	Small on-site liquid streams	Matrix sensitivity
Incineration	Destruction	Very high	Concentrated liquids/solids and regenerants	Matrix sensitivity, power cost

9. Conceptual dimensioning for 1,000 m³/day

Below is a conceptual—not guaranteed—design basis intended for feasibility screening. The numbers are suitable for a budgetary discussion and must be refined by pilot data, PFAS speciation, TOC, salinity, hardness, sulfate, silica, foaming behavior and the regulatory targets of the site.

Train	Illustrative mass/flow logic	Comment
A). SAFF → Electrooxidation or SCWO/HALT	1,000 m^3/d feed → ~20 m^3/d PFAS-rich foamate/concentrate to destruction (EO)	Most attractive when PFAS profile is amenable to foam concentration
B). RO/NF → evaporator → SCWO/HALT or incineration	1,000 m^3/d feed → ~50 m^3/d reject → ~3–5 m^3/d final concentrate to destruction	Useful for broad PFAS capture, especially short chain

PFAS removal, concentration, destruction and market opportunities

Train	Illustrative mass/flow logic	Comment
C) IX→ evaporator → SCWO/HALT or incineration	1,000 m^3/d feed → ~20 m^3/d reject → ~2-3 m^3/d final concentrate to destruction	Excellent where low finished-water targets are required
C). GAC → spent media management or incineration	1,000 m^3/d feed → no liquid destruction train required on site unless resin regenerant is produced	Simpler plant but shifts life-cycle burden to media handling

10. Technical-economic comparison (order-of-magnitude ranges)

The cost ranges below are order-of-magnitude screening values intended for concept evaluation only. Real costs depend strongly on PFAS concentration, chain distribution, matrix chemistry, destruction endpoint, utilities, local labor and whether OPEX is normalized to feed flow or to concentrate flow.

Stage	Technology	Indicative OPEX	Indicative CAPEX for 1,000 m^3/day project
Primary treatment	Foam fractionation	0.15–0.50 USD/m^3 feed	1.0–2.5 M USD
Primary treatment	Ion exchange	0.30–1.00 USD/m^3 feed	1.0–2.0 M USD
Primary treatment	RO/NF	1.0–3.0 USD/m^3 feed	2.0–5.0 M USD
Secondary concentration	Evaporator on sidestream	3–8 USD/m^3 of concentrate	0.4-1.5 M USD
Final destruction	SCWO / HALT/EO	8–25 USD/m^3 of final concentrate	1.5–6.0 M USD

Integrated budgetary ranges for a complete plant concept are approximately 6–8 M USD for SAFF + destruction, 5–8 M USD for RO/NF + evaporator + destruction, 4-8 M USD for IX+ evaporator + destruction depending on complexity and the size of the final destruction package.

11. Market opportunities

- Municipal drinking water compliance projects.
- Airport, military and firefighting training-site remediation.
- Landfill leachate treatment and regional destruction hubs.
- Industrial wastewater from fluorochemical, semiconductor and metal-finishing operations.
- Mobile and leased systems for emergency or interim PFAS response.
- Municipal and industrial treatment driven by tighter PFAS monitoring and drinking-water requirements.
- Waste management and landfill leachate treatment, particularly in countries with advanced environmental compliance.
- Chemical, specialty materials, electronics and semiconductor sectors.
- Centralized destruction hubs linked to concentration or ZLD platforms.

For a company experienced in evaporation, thermal systems and industrial wastewater, the strongest business entry point is often not the first-stage adsorbent market, but the middle and last part of the train: secondary concentration, integration, and final destruction partnerships.

12. Leading technology providers (with websites)

Segment	Company	Role in PFAS market	Website / information link
Separation / concentration	Calgon Carbon	Activated carbon PFAS adsorption and related PFAS offering	https://www.calgoncarbon.com/pfas/
Separation / concentration	Purolite	Ion exchange resins for PFAS removal	https://www.purolite.com/index/core-technologies/industry/potable---groundwater/pfas-removal-with-resin-technology
Separation / concentration	Xylem / Evoqua	PFAS treatment and remediation solutions	https://www.xylem.com/en-uk/applications/pfas-pfoa-pfos-contaminant-treatment/
Separation / concentration	Ovivo	Integrated PFAS concentration and destruction toolbox	https://www.ovivowater.com/en/technologies/per-and-polyfluoroalkyl-substances-pfas/
Separation / concentration	EPOC	SAFF foam fractionation	https://epocenviro.com/
Separation / concentration	OPEC Systems	PFAS remediation deployment, including SAFF-related offering	https://opecsystems.com/enviro/pfas-solutions/
Separation / concentration	Condorchem	Integrated PFAS separation/concentration/ destruction	https://condorchem.com/en/blog/effluent-treatment-pfas/
Destruction	Revive Environmental	SCWO PFAS Annihilator	https://revive-environmental.com/pfas-annihilator/
Destruction	374Water	AirSCWO destruction	https://374water.com/our-technology/
Destruction	Aquagga	Hydrothermal PFAS destruction units	https://www.aquagga.com/
Destruction	Aclarity	Electrochemical PFAS destruction	https://www.aclaritywater.com/technology/

13. Recommended positioning and business opportunity assessment

A company with strength in evaporation, thermal systems, industrial wastewater treatment and ZLD can position itself in the PFAS market without competing head-on with every adsorbent supplier.

- Offer evaporator-based sidestream concentration packages specifically designed for PFAS rejects, foamates and regenerants.
- Partner with destruction specialists (SCWO, hydrothermal, electrochemical) rather than reinventing the entire destruction platform initially.
- Develop regional PFAS concentration + destruction hubs for leachate and industrial residuals.
- Target Europe and USA landfill, remediation and industrial sidestream markets where economics favor concentration plus destruction.
- Use pilot units and leasing models to lower customer adoption barriers.

14. Key conclusions

4. PFAS treatment is not one market but several: potable water polishing, remediation, landfill leachate, industrial wastewater and destruction services.
5. The strongest integrated technical concept is usually capture/pre-concentration first, then evaporator concentration, then destruction of the smallest possible residual stream.
6. Foam fractionation has a particularly attractive role where PFAS behave as surface-active contaminants and where minimizing the destruction volume is critical.
7. SCWO and hydrothermal alkaline destruction are among the most credible routes for concentrated PFAS liquids, while electrochemical systems can be attractive for selected smaller sidestreams.
8. For Europe and the USA, the best immediate business opportunities lie in landfill leachate, remediation sidestreams, industrial concentrates and centralized destruction service models.