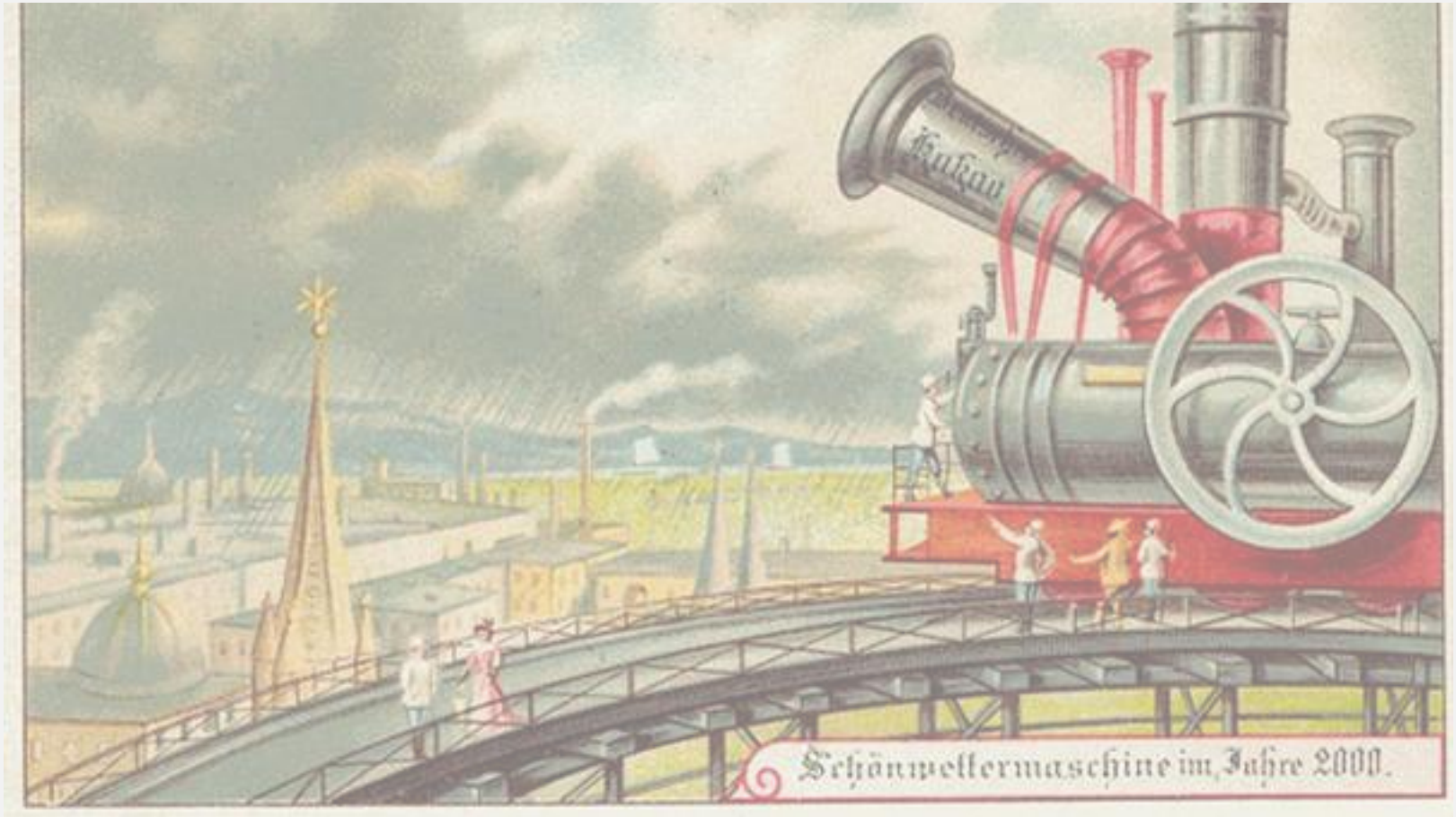
HighTechXL

PFAS &
CO2 capture



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From demonstration to Realisation

ARAMIS

Expectations

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luctivity

Innovation
Trigger

Out of the valley, into the light

Some key Updates and Projects 2025:

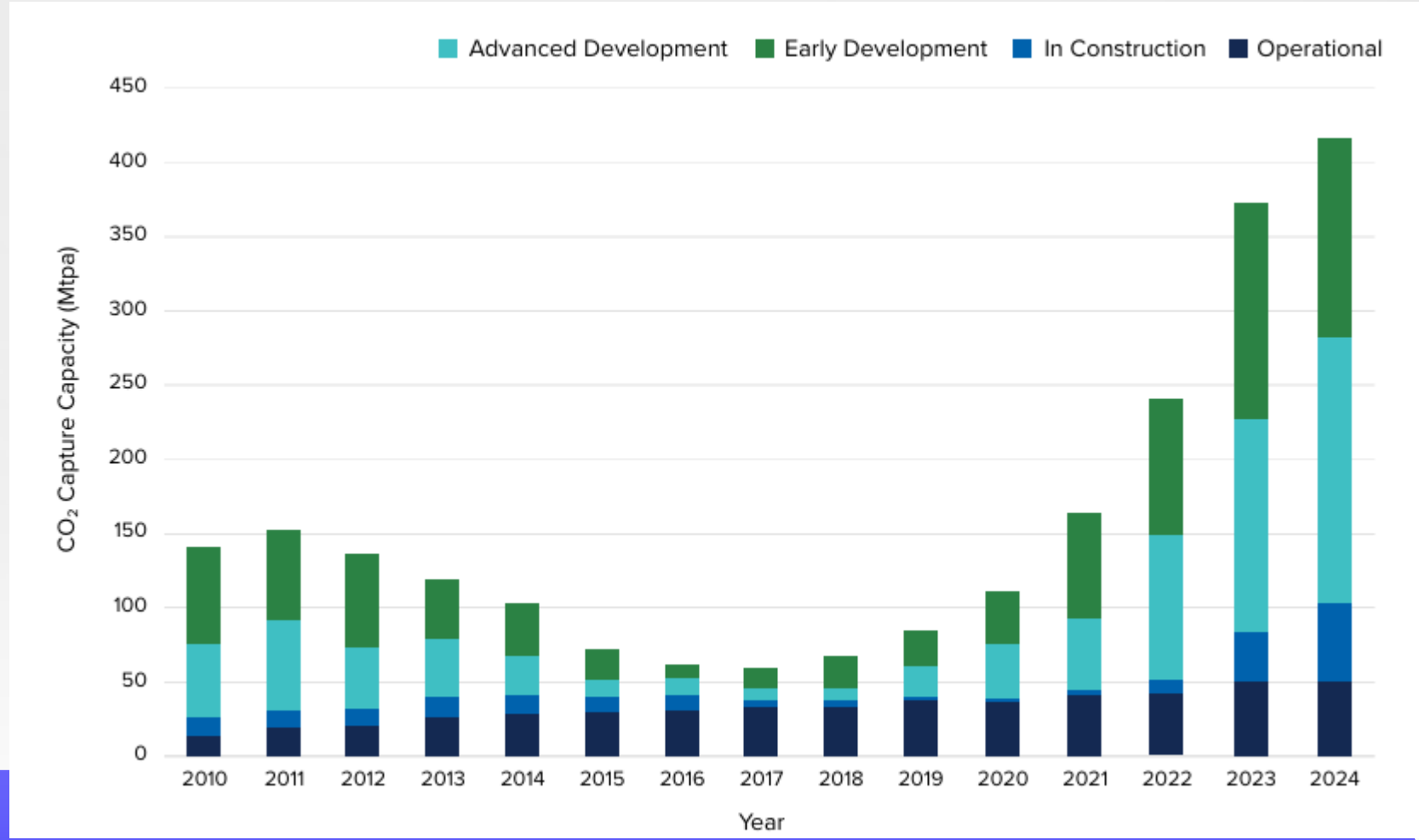
Netherlands: Twence's Modular Carbon Capture Plant (SLB Capturi)

United Kingdom: enfinium's CCS Pilot Programs

Canada: Alberta's Waste-to-Energy CCS Project → $300 million plant will process 150,000 tonnes mun. waste

European Union: Major Funding for WtE CCS:

- Öresundskraft AB's Innozhero project will receive €54 million to build a CCS facility capable of capturing 200,000 tonnes of CO_2 per year by 2026.
- Herambiente's Ferrara WtE plant in Italy will receive €24 million to install enzymatic CCS technology, targeting a 90% capture rate (64,000 tonnes of CO_2 annually), using renewable geothermal heat



Pipeline of CCS projects capture capacity from the Global Status of CCS Report 2024

PFAS & CO2

1. How much and which PFAS is going to the capture plant?
2. What is the effect of this PFAS on the capture plant itself
3. How much PFAS will be in the treated flue gas?
4. How will PFAS influence CO2 quality?

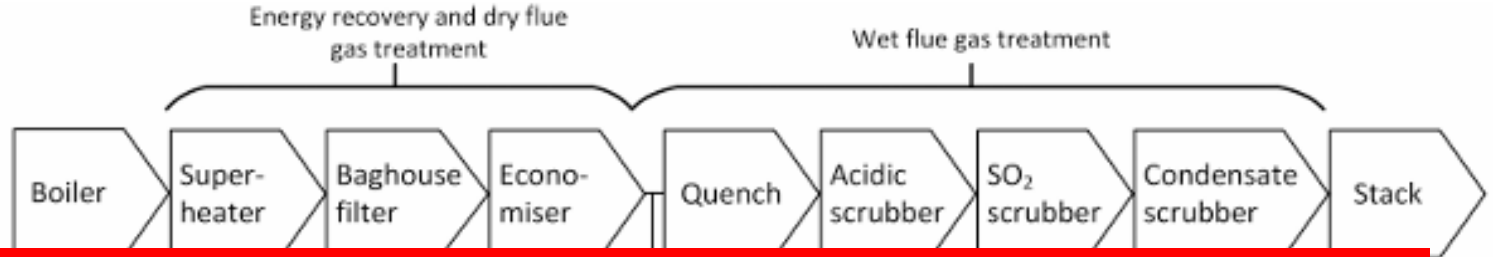
PFAS entering the capture plant

PFAS detected in flue gas, ash, condensate, and other residues

Typical concentrations: **4–20 ng/m³ in flue gas**; higher in condensate and ash

Wet flue gas treatment can reduce PFAS levels by ~35%, but efficiency varies by compound
Some PFAS (e.g., PFHxA) are efficiently captured; others (e.g., PFBA) are not

PFAS entering the capture plant



Perfluoroalkanes (fully fluorinated alkanes like CF4, C2F6) are known to be thermally stable and can be present in flue gas, but their specific concentrations are generally not reported separately in these studies.

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Streams

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Cite This: *Environ. Sci. Technol.* 2024, 58, 8457−8463

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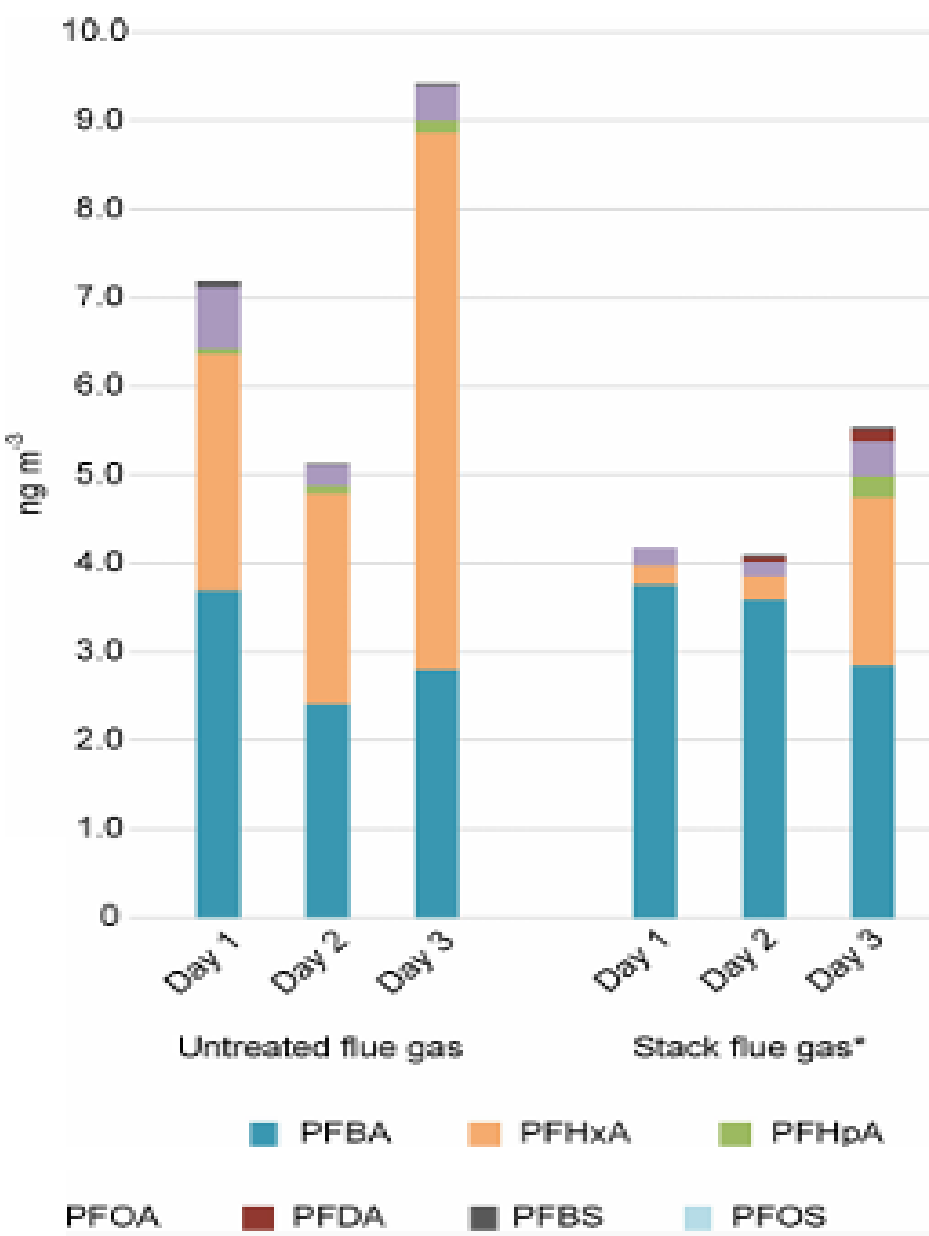
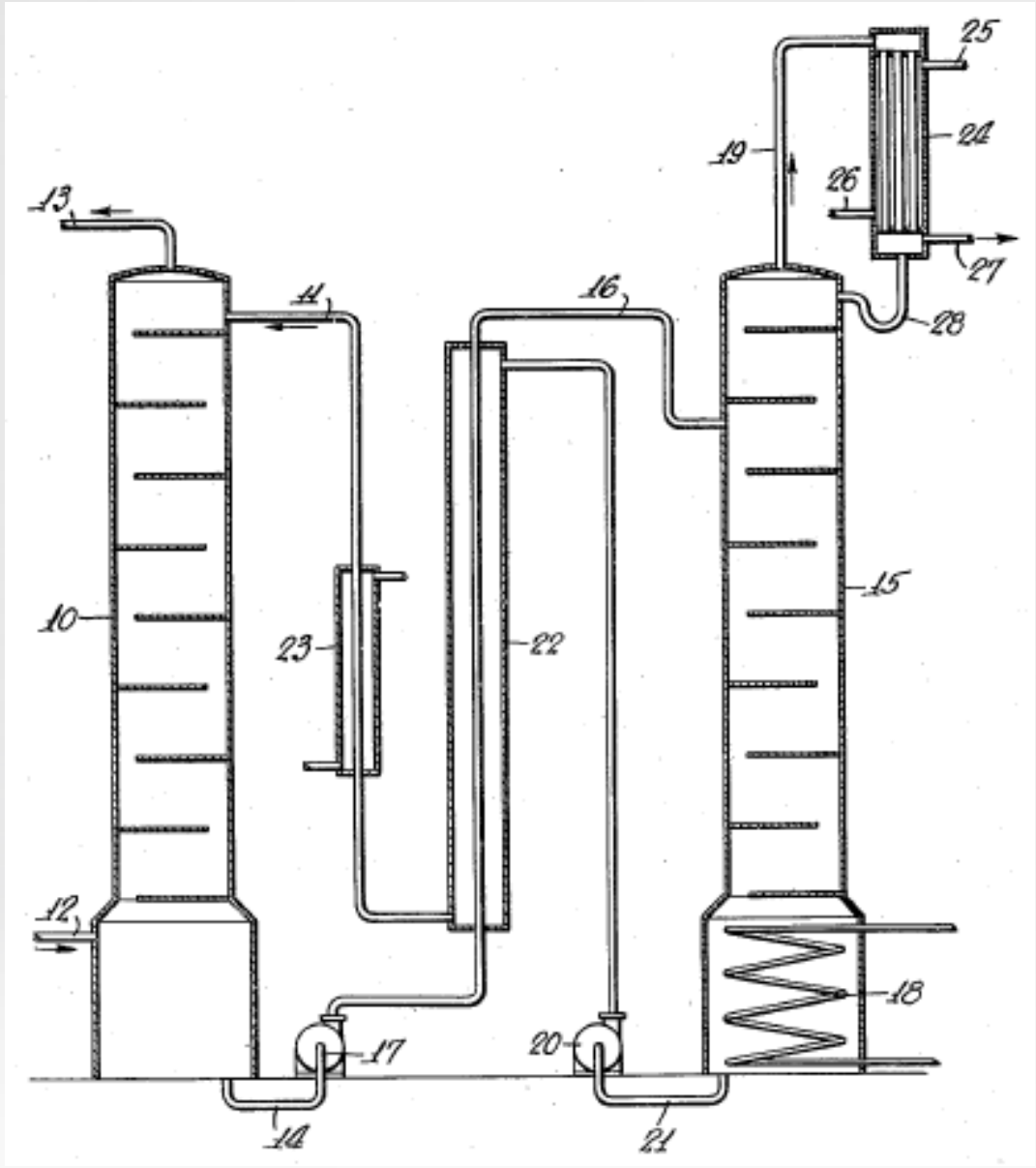


A worldclass example: AVR DUIVEN



PFAS expected to enter the capture plant as gaseous components and as solids (eg flue ash)

PFAS effect on the capture plant

Most PFAS are expected to be removed during CO_2 recovery, but some polar, non-dissociating PFAS may end up in the captured CO_2 stream or in the treated flue gas

Total PFAS (ng/g) in solid streams

Solid							
Boiler ash	n.d.	n.d.	n.d.	0.67	0.40	1.2	
Filter ash	0.28	0.79	0.70	0.75	0.13	0.37	
APCR†*	n.d.	n.d.	n.d.	1.3	0.99	1.1	ng g^{-1}
Bottom ash*	0.16	n.d.	0.54	1.4	0.81	1.5	
Gypsum*	n.d.	n.d.	n.d.	0.31	0.17	0.26	

PFCAs like PFHxA and occasionally PFOA are the main PFAS species captured on fly ash, with some variability in PFSA presence (e.g., PFOS) depending on specific plant conditions and waste feedstock.

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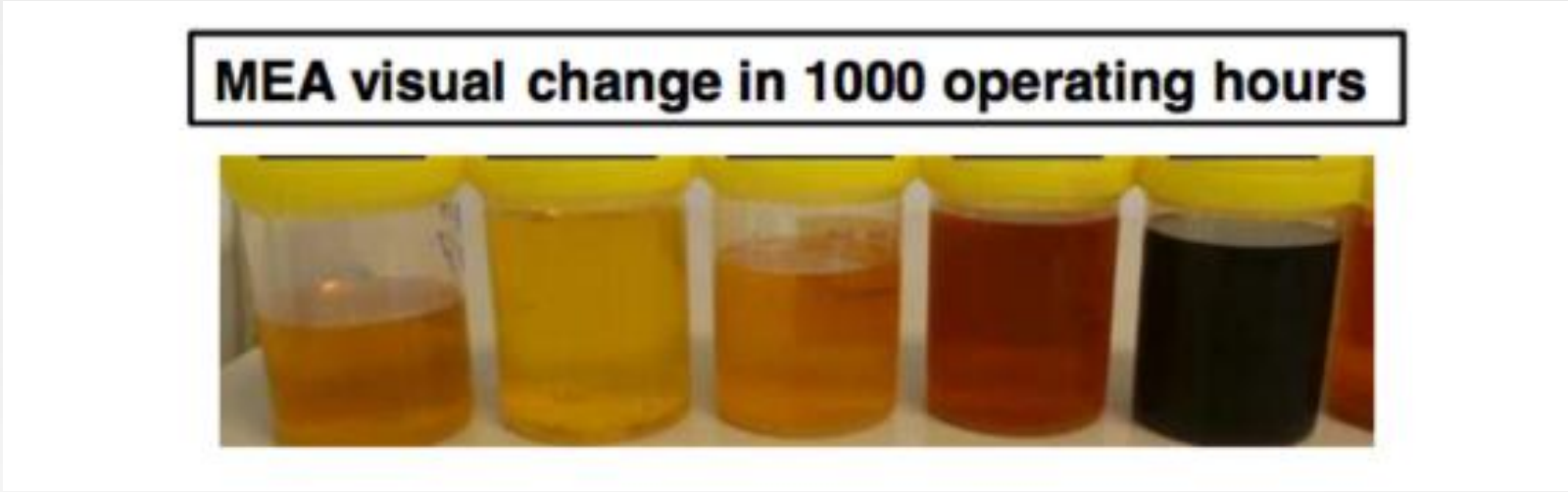
Solvent reclaiming



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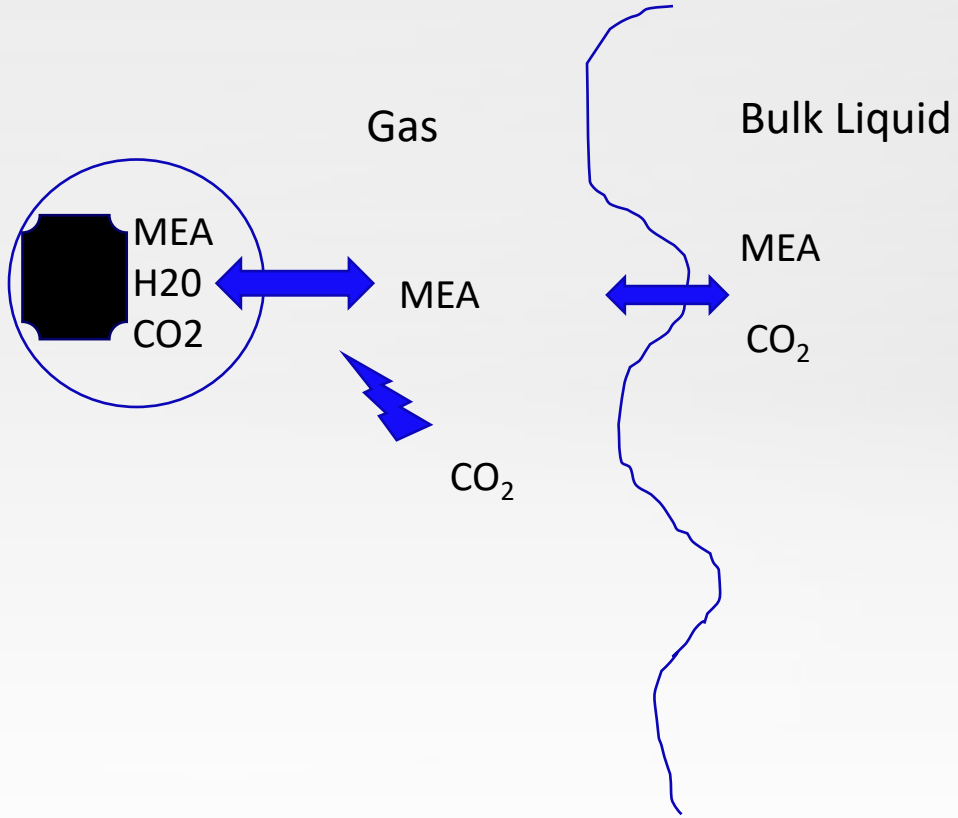
Aerosol based emission



PFAS in treated flue gas

Short-chain PFAS, fluorotelomer alcohols, and certain substituted perfluoroalkane sulphonamido ethanols are most likely to persist through incineration and gas cleaning

- Short-chain perfluorocarboxylic acids (PFCAs)

PFBA (perfluorobutanoic acid, C4) and PFHxA (perfluorohexanoic acid, C6)

- Fluorotelomer alcohols (FTOHs)

3-5:2 FTOH (fluorotelomer alcohols with 3–5 fluorinated carbons) exhibit high volatility and low adsorption affinity, enabling them to bypass wet scrubbing systems

- Substituted perfluoroalkane sulfonamido ethanols

MeFASEs and EtFASEs (methyl and ethyl derivatives) persist due to their non-dissociating, polar nature, allowing them to partition into recovered CO_2 streams

- Perfluoroalkanes (PFCs)

Fully fluorinated alkanes like PFHx (perfluorohexane) show low reactivity and high thermal stability, surviving incineration and gas cleaning

PFAS effect on CO2 quality

No published measurements of PFAS in recovered CO_2 to date

Standard fluoride tests are not suitable for PFAS; specific PFAS analysis or total organic fluorine (TOF) methods are needed
Detection limits for PFAS in flue gas: 0.1–0.5 ng/m³; for CO_2: estimated 10 ng/m³

Upgrading via adsorption Media
Eg Granular activated carbon (GAC):

- Less effective for short-chain PFAS (e.g., PFBA, PFHxA) due to lower adsorption capacity. Breakthrough occurs 2–3x faster than for long-chain compounds like PFOS
- Functional group impact: Sulfonate-containing PFAS (e.g., PFOS) adsorb better than carboxylates (e.g., PFOA) of equivalent chain length

When are we happy?

Conclusions & Recommendations

PFAS are not fully destroyed during waste incineration and can be found in flue gas, ash, and condensate.

Wet flue gas treatment can reduce but not eliminate PFAS; capture efficiency depends on PFAS type.

Most PFAS are expected to be removed during CO_2 recovery, but some may contaminate the captured CO_2 stream.

There is a critical need for improved measurement, monitoring, and treatment technologies to address PFAS in WtE and CO_2 capture processes

Zero doesn't exist

Great to have you on board of the change

Let’s energise innovation together

Questions?