Best Available Techniques, innovation and permitting

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2 recent BAT-studies on PFAS abatement in Flanders

- **Water**
  - → PFAS-containing industrial wastewater and drainage water

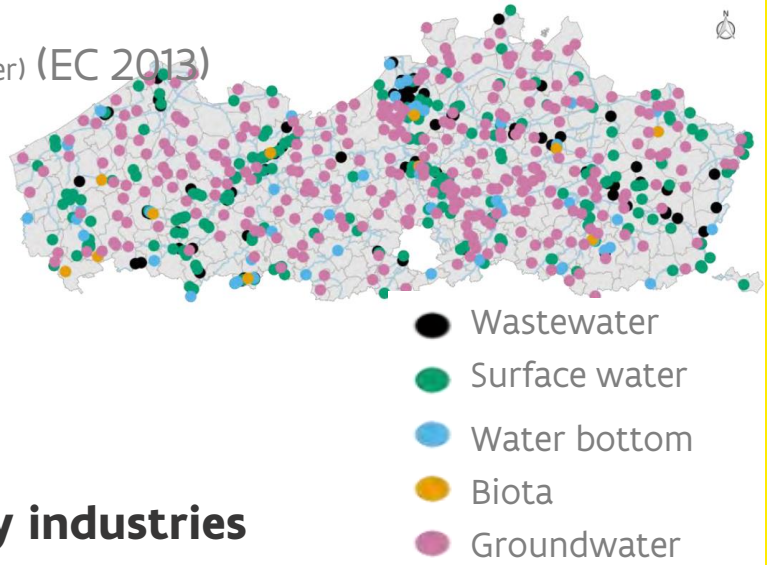
- **Air**
  - → Prevent and limit PFAS emissions to air

PFAS treatment in industrial wastewater

Annelies Baert

PFAS is widespread in Flanders

- **Water quality follow-up by Flanders Environment Agency**
- **Surface water**
  - → PFOS concentrations > EQS PFOS
  - → EQS PFOS: 0,65 ng/l (average rivers & lakes – fresh water) (EC 2013)
  - → Median concentration ∑PFAS: 45 ng/l
- **Groundwater**
  - → 17 ≠ PFAS
  - → Median concentration ∑PFAS: 8,7 ng/l
- **Frequent use of ground- & surface water by industries**



PFAS > EQS: obligation to take action

- **Water Framework Directive:**
  - → EQS = concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded in order to protect human health and the environment

- **Application of Best Available Techniques (BAT)**
- **Go beyond BAT**
  - → Industrial Emissions Directive: "Where an environmental quality standard requires stricter conditions than those achievable by the use of the best available techniques, additional measures shall be included in the permit, […]."
  - → Water Framework Directive: "Where a quality objective or quality standard, […], requires stricter conditions than those which would result from the [emission controls based on best available techniques], more stringent emission controls shall be set accordingly."

Flemish BAT-study

on PFAS-containing industrial wastewater

By VITO

Aim

- **Cross-sectoral study**
- **Techniques to treat PFAS**
  - → Best Available Techniques & emerging techniques
  - → Industrial wastewater, incl. discharge of drainage water
- **Out of scope**
  - → Determination of emission limit values

emis vito Vlaanderen

Inventory of techniques

Separation & concentration

- → Adsorption
  - × Activated carbon (TRL 9)
  - × Ion exchange resins (TRL 9)
  - × Other adsorption media (TRL 3-7)
- → Coagulation
  - × Coagulation/flocculation (TRL 6-7)
  - × Electrocoagulation (TRL 5)
- → Membrane-based
  - × Reverse osmosis (TRL 9)
  - × Nanofiltration (TRL 9)
- → Other
  - × Foam- & ozofractionation (TRL 7-8)
  - × (Vacuum) Evaporation (TRL 7-9)

Destruction

- → Advanced oxidation processes
  - × Photo- / electrocatalytic degradation (TRL 5-6)
  - × (Electro)chemical oxidation (TRL 3-6)
  - × Supercritical water oxidation (TRL 4-6)
- → Advanced reduction processes
  - × Chemical reduction (TRL 5)
  - × Non-thermal plasma (TRL 6-8)
- → Biological treatment
  - × Microbe-based bioremediation (TRL 3-4)
- → Other
  - × Thermal degradation & incineration (TRL 8-9)
  - × Sonochemical degradation (TRL 4-5)
  - × High energy e-beam (TRL 4)
  - × Photolysis (TRL 3-4)

Specifics of techniques

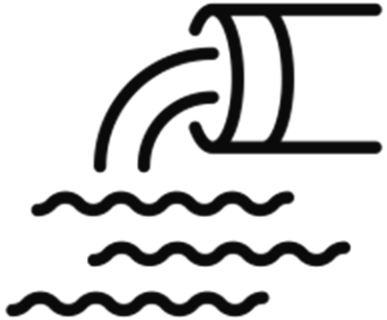
- **Demonstration reached: TRL ≥ 7**

	Long chain	Short chain	Flow	EBCT	Volume-reduction	Matrix
GAC	++	−+	+	15 - 45 min	+	−
IEX	++	+	+	2 - 10 min	+	−−
Clay	++	+	+	2 - 15 min	+	−+
Coagulation/ flocculation	++	−	−+	30 - 60 min	+	+
NF	++	−+	++	/	−	−
RO	++	++	++	/	−	−
Foam & ozofractionation	++	−+	−+	30 - 45 min	++	+
Vacuum evaporation	++	++	−	/	+	+
NT Plasma	++	+	−	Few sec.	++	+
Thermal degredation	++	++	−−	2 – 4 s	++	++

Conclusions

- **Case specific approach**
  - → Selection of the most suited technique or combination of techniques
  - → Depends on:
    - × PFAS concentration
    - × Type PFAS
    - × Flow
    - × Matrix / wastewater characterisation
  - → Lab or pilot testing

- **Industrial wastewater**
  - → Always BAT to treat PFAS
- **Drainage water**
  - → Always BAT to treat PFAS
    - × High flows OR a long period (e.g. bigger construction works)
  - → From case to case BAT to treat PFAS
    - × Lower flows for a short period
  - → Not BAT to treat PFAS
    - × Low flows for a very short period (e.g. rainwater well)



Optimisation of the design & management of the technique(s)

Monitor PFAS removal by the technique(s)

Permitting

- **Emission limit values via the permits**
  - → Aiming as low as possible
    - × Lowest concentration possible via our monitoring method: 100 ng/l => 20 à 50 ng/l
  - → Limited in time
  - → Research
    - × Sources
    - × Technique(s)

Future challenges

- **Achieve EQS for PFOS & PFAS**
- **Development of techniques**
  - → Better removal performances of existing techniques
  - → Innovation
- **Short & ultrashort chain PFAS**
  - → Methods to measure them
  - → Technique(s) to treat them
- **Increase knowledge on PFAS usage & occurrence**

- **Update of BAT-study on industrial wastewater in 2025**

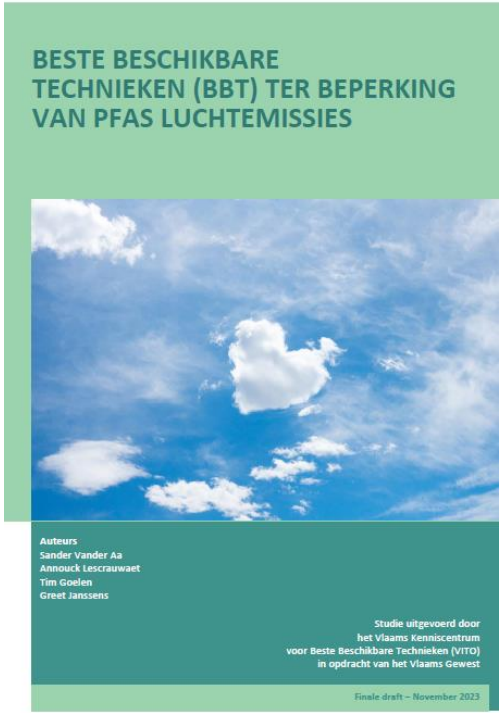
Prevent and limit PFAS emissions to air

Vicky Demeyer

BAT-study “Prevent and limit PFAS emissions to air”

- Limited quantitative information on emission levels
- Large and very diverse number of activities

- Techniques at a general level
- Focus on air emissions → conlusions valid for other environmental compartments/other SvHC



Inventory of PFAS risks

Inventory of known and expected PFAS components

Best efforts obligation

Emissions to air/water/soil, presence in waste materials and by-products

Limiting the use of and minimising emissions

Prevent the use of PFAS components/limit by substitution

Process-integrated measures at source

Extraction and treatment of waste gases

5-yearly reporting to competent authority

General air emission limit values

- **Sum of PFAS of very high concern**
  - → 0,05 mg/Nm^3 - exemption limit: 0,075 kg/year/emission point
- **Safety net**
  - → Limited quantitative information → not obvious to derive BAT-AEL
  - → Not a sufficient, but a necessary condition
- **Research for minimisation remains valid**
- **Temporary derogation possibility in the permit**
  - → Proportionality and cost-effectiveness
  - → Immission and deposition assessment and environmental risks

Monitoring requirements

Annual report of all PFAS emissions to air

Annual mass balance of PFAS components

2-monthly monitoring of channeled emissions
- specific activities
- if PFAS emissions pose significant risks

Yearly monitoring of other relevant channeled emissions

Immission and deposition assessment

Limit value PFAS in ambient air??

- Temporary assessment value for ‘EFSA’ PFAS: 0,4 ng/m^3
- Conservative approach: all measurable PFAS
- Human exposure via breathing

Limit value PFAS deposition??

- No temporary assessment value
- Persistent substances accumulate: most critical
- Deposition modeling not obvious

New provisions in IED – article 14a

2. The EMS shall include at least the following

(d) a **chemicals inventory** of the hazardous substances present in or emitted from the installation as such, as constituents of other substances or as part of mixtures, with special regard to the substances fulfilling the criteria of Article 57 and substances addressed in restrictions in Annex XVII to Regulation (EC) No 1907/2006, and **a risk assessment of the impact of such substances on human health and the environment**, as well as and an analysis of the possibilities to **substitute** them with safer alternatives or **reduce their use or emissions**;

(e) **measures taken to achieve the environmental objectives and avoid risks for human health or the environment**, including corrective and preventive measures where needed;

New provisions in IED – article 14(1)

(ab) appropriate requirements ensuring the **assessment of the need to prevent or reduce the emissions of substances fulfilling the criteria of article 57** or substances addressed in **restrictions in annex XVII** to regulation (EC) No 1907/2006.

Permitting substances of very high concern

- Inventory of (PFAS) risks → which substances are emitted
- ELV/BAT-AEL = safety net
- Emission + immission monitoring
- Burden of proof of acceptability for companies
- Minimisation principle
- Research into mitigating measures
- Proportionality and cost-effectiveness