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Materials Science and Technology

PMT/vPvM

Group 3
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What are PMT/vPvM?

Persistent
Mobile
Toxic

very
Persistent
very
Mobile

- **Persistence**: do not degrade easily in the environment, can remain for long periods after release
- **Mobility**: travel readily through water, including surface water, groundwater, causing large-scale contamination
- **Toxicity**: harmful to human health and aquatic ecosystems, even at low concentrations

What are PMT/vPvM?

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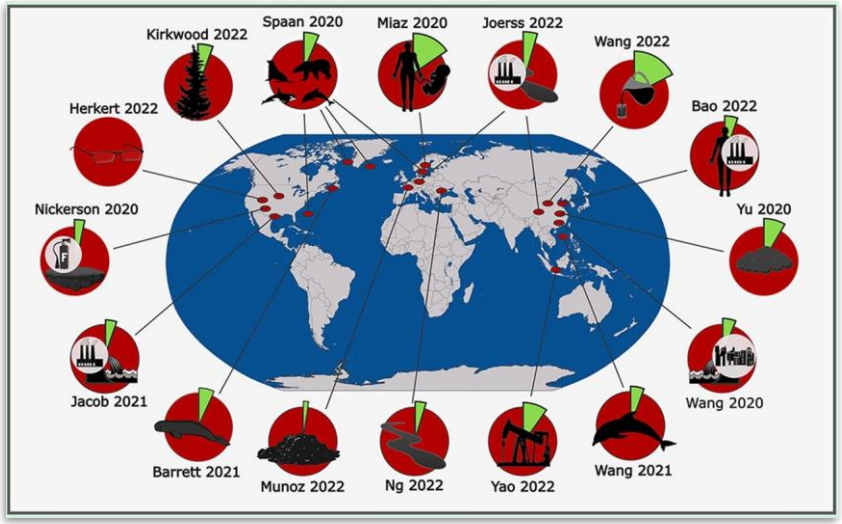
PFAS – textile, packaging, coatings, cosmetics



DDT – insecticides

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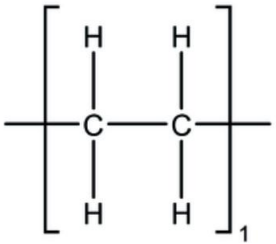
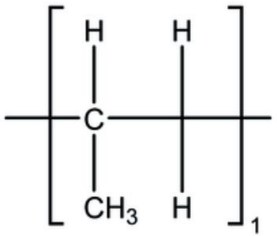
Current concerns about the pollution caused by their use

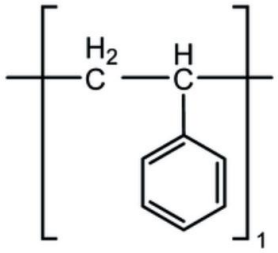
Plastic Waste and Environmental Pollution



Polyethylene - PE



Polypropylene - PP



Polystyrene - PS

- Synthetic polymers persist for centuries
- High mobility in soil and water systems → difficult to contain
- Millions of tons enter the ocean annually → harm marine ecosystems
- Poor waste management leads to toxic emissions from plastic burning

Current concerns about the pollution caused by their use

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Microplastics: A Growing Concern

- Formed from plastic degradation
- Found in water, soil, air → enter the food chain
- Detected in human blood
- Potential health risks: inflammation, hormonal imbalances, cellular damage
- Transport toxic chemicals, increasing exposure risks

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Current concerns about the pollution caused by their use

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Toxic Additives and Chemical Leaching

- Plastics release chemicals: plasticizers, flame retardants, stabilizers
- Contaminate drinking water and ecosystems
- Degraded plastics absorb heavy metals, pesticides

→ increase pollution

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Waste Management

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The Challenges of Recycling

- Not all plastics are recyclable:

  Thermoset (epoxy resin, PUR) vs

  Thermoplastic (PE, PP)

- Plastic degradation after recycling
- Recyclable ≠ Recycled

  Mixed materials, contamination, inefficiencies

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Possible Solutions and Future Perspectives

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Analytical Advancements

Limitations in detecting PMT/vPvM substances in environmental samples.

New techniques are being developed:

- Super-critical fluid chromatography (SFC)
- Reversed-phase liquid chromatography (RPLC) coupled to hydrophilic interaction liquid chromatography (HILIC)

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Possible Solutions and Future Perspectives

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Promising Approaches

Biodegradable Polymers (PLA and PHA) – high costs/conditions

Chemical Recycling: break down into monomers for reuse

Stricter Regulations:
- Bans on single-use plastics
- Extended producer responsibility (EPR) programs
- Incentives for sustainable packaging
- Circular economy
- Public Awareness

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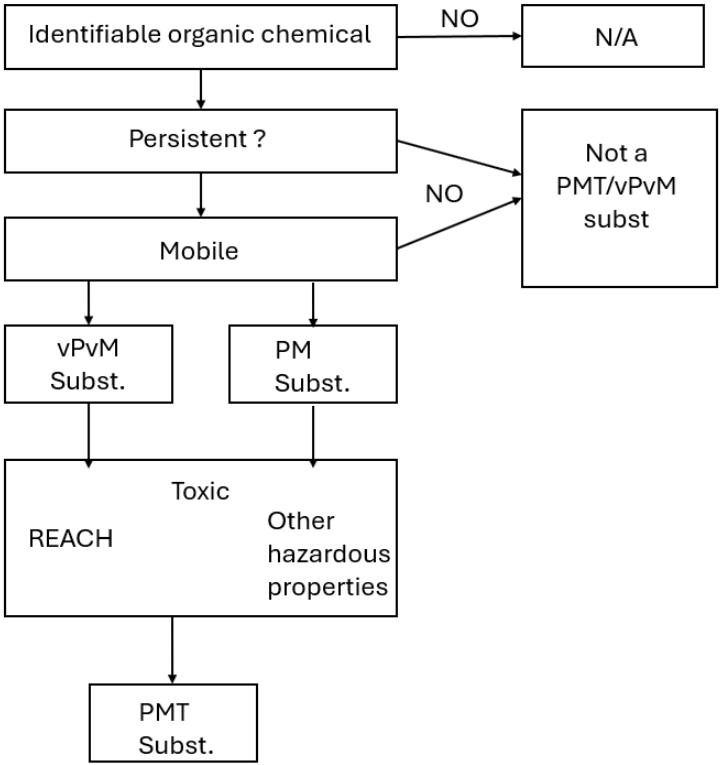
What to do to overcome PMT/vPvM substances



Guideline for PMT/vPvM assessment , *SETAC Europe 2022 conference : Hans Peter H Arp*

1. **Regulatory improvement**: Identification under PMT/vPvM now possible under the article 57f of the REACH (registration, evaluation, authorisation and restriction of chemicals), *Hale et al. Environ. Sci. Technol. 2020, 54, 14790−14792*.

What to do to overcome PMT/vPvM substances pollution?

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2. **Substances replacement:** Evaluate the industry necessity to use those substances, consider replacing them.

   => REVAC, a system used in Sweden to better monitor watershed level

REVAQ®

Renare vatten – bättre kretslopp

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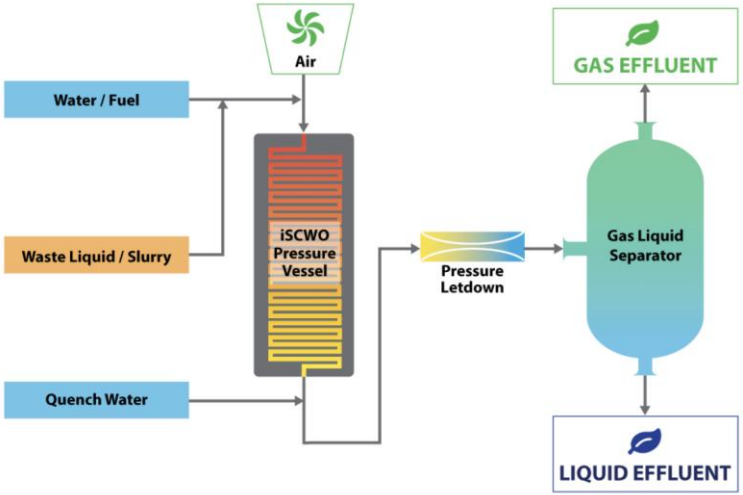
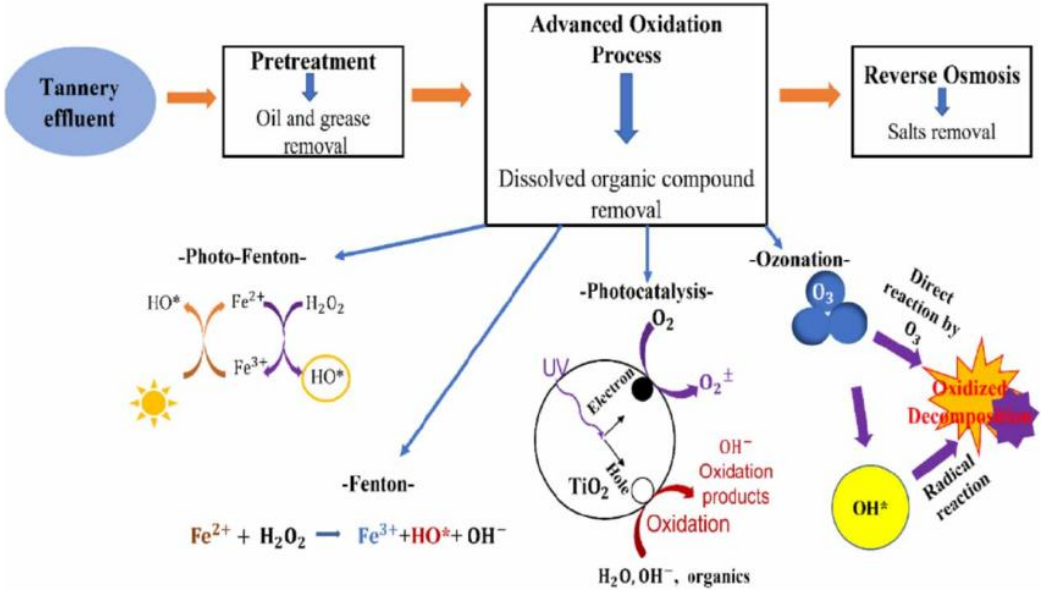
Supercritical Water Oxidation (SCWO)



- **Process:** Uses supercritical water (T > 374°C, P > 221 bar) to oxidize pollutants.
- **Efficiency:** >99.9% destruction of PMT & vPvM substances.
- **Commercial Use:** General Atomics' PERSES™ eliminates PFAS (99.99% efficiency).
- **Challenges:**
- Reactor corrosion under extreme conditions.
- Salt precipitation causing blockages.
- Ongoing research on materials & process improvements.

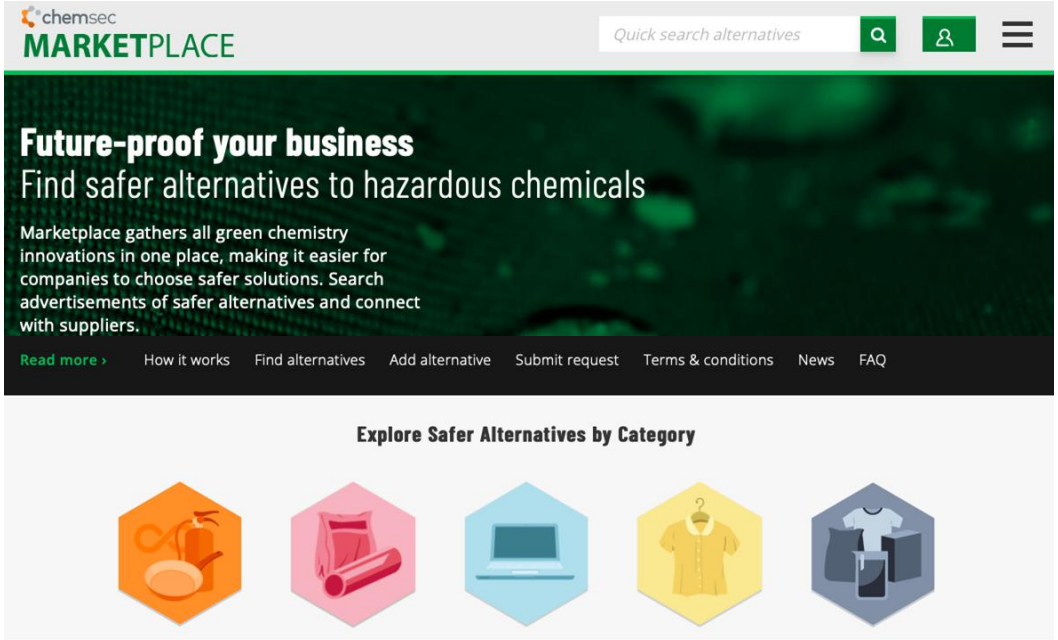
Advanced Oxidation Processes (AOP)



- **Process:** Hydroxyl radicals (·OH) degrade persistent pollutants.
- **Common Methods:**
- **UV/H_2O_2:** UV activates hydrogen peroxide to form ·OH.
- **Ozone-Based:** Ozone reacts to generate ·OH.
- **Fenton's Reagent:** H_2O_2 + iron salts produce ·OH.
- **Challenges:**
- High chemical & energy costs.
- Water constituents (e.g., chloride, organic matter) reduce efficiency.
- Pre-treatment often needed.
- **Application:** Used in wastewater treatment to improve effluent quality.

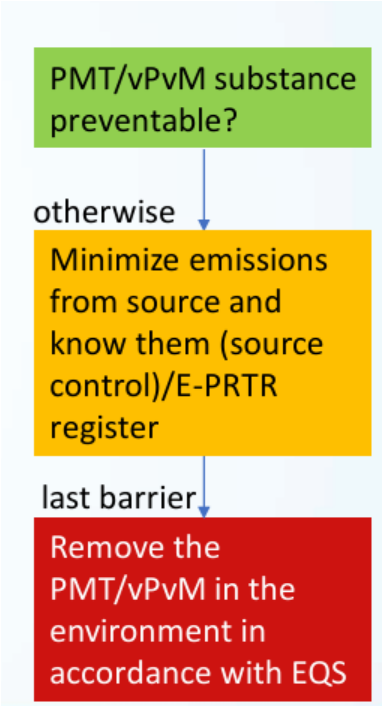
What can we do at our own scale?

1. Change our consumption habits to be more responsible
2. Raise awareness and inform ourselves
3. Supporting or getting involved in local initiatives



https://marketplace.chemsec.org/

To conclude



- **ZeroPM (EU-funded, since 2021):** a partnership of research centers and universities working together to link prevention, prioritization, and removal strategies for PM