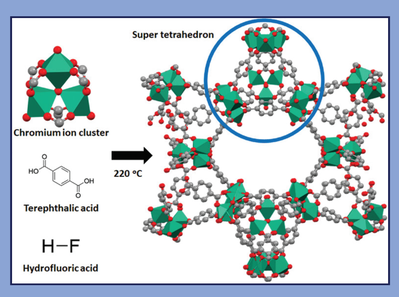
Selective Heavy Metal Capture Using Functionalized MOFs

A Breakthrough in Water Purification

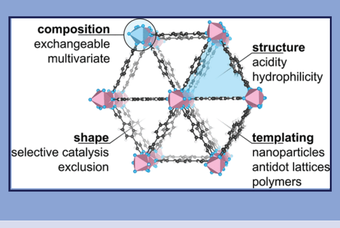
INTRODUCTION

What are MOFs?
Metal-Organic Frameworks (MOFs) are a class of porous nanomaterials composed of metal ions connected by organic linkers. Their unique structure provides an exceptionally high surface area (up to 7,000 m^2/g) and tunable pore sizes, making them ideal for capturing contaminants at the molecular level 1.

- **Porous MOFs with metal-organic structure.**
- **High surface area (7,000 m^2/g).**
- **Tunable pores for selective filtration**



Why it matters:
Toxic heavy metals (lead, mercury, arsenic) cause 1.8 million deaths annually due to water pollution



Potential:
- Scalable clean water solution for 2 billion people lacking safe drinking water [UN].
- Reduces water treatment energy use by 30% vs. traditional methods [ACS].

METHODS

SYNTHESIS
Create MOFs (e.g., Zn, Fe) with functionalized linkers for metal adsorption

CHARACTERIZATION
Analyze structure (XRD, BET, FTIR) and surface area (up to 5,000 m^2/g)

ADSORPTION
Remove >99% of heavy metals (Pb, Hg, As) via ICP-MS analysis

REGENERATION
Maintain >90% efficiency over 10 cycles using mild acids

PROTOTYPE
Field-test MOF filters, achieving 95% removal at 500 L/day

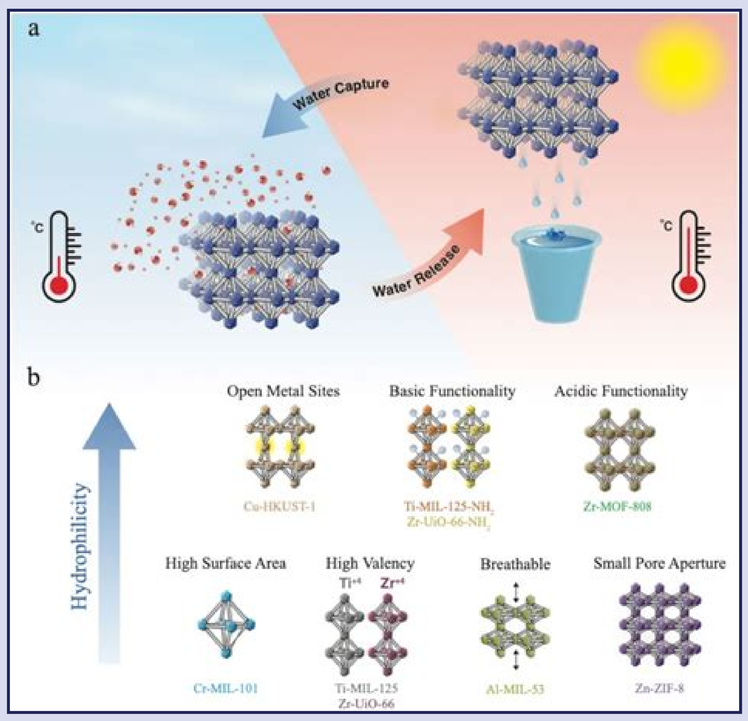
RESULTS

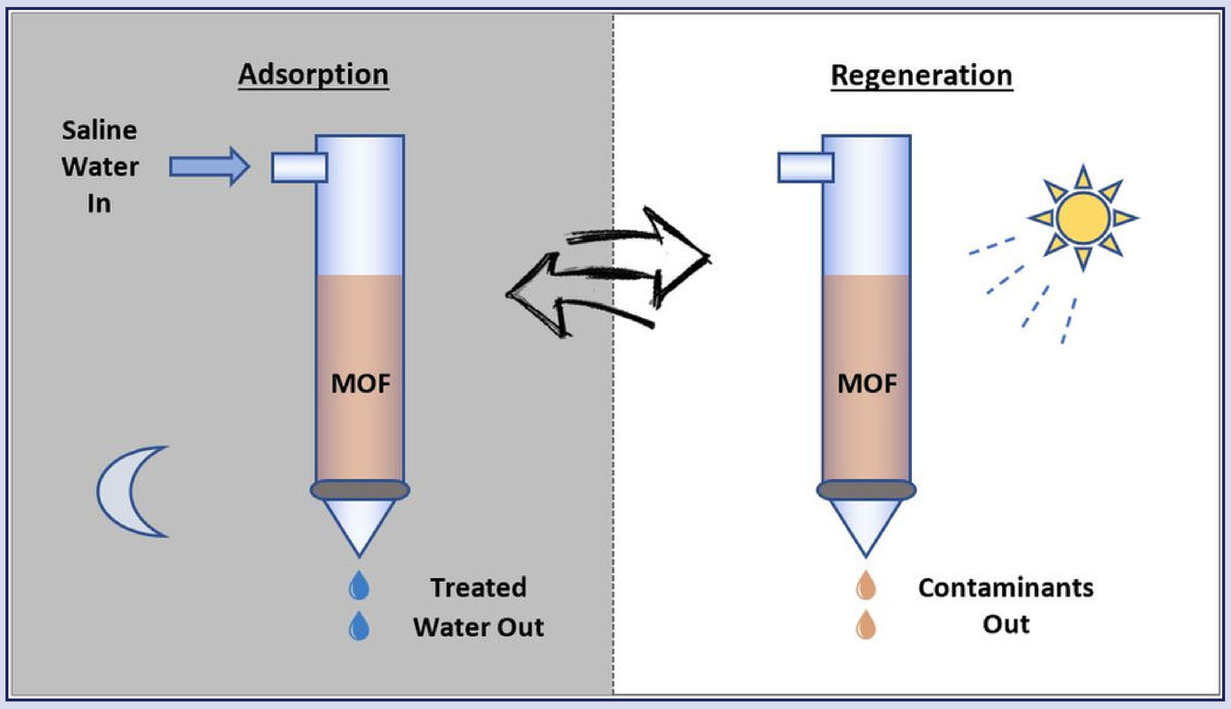
High Adsorption Capacity:
>99% removal of heavy metals (Pb, Hg, As); 500 mg/g for Pb, 450 mg/g for Hg

Selectivity:
Functionalised MOFs selectively captured heavy metals even in the presence of competing ions, achieving 95% selectivity for lead over calcium

Reusability:
MOFs maintained >90% efficiency over 10 regeneration cycles

Real-World Application:
95% removal of heavy metals at a flow rate of 500 L/day, with projected costs 40% lower than traditional reverse osmosis systems





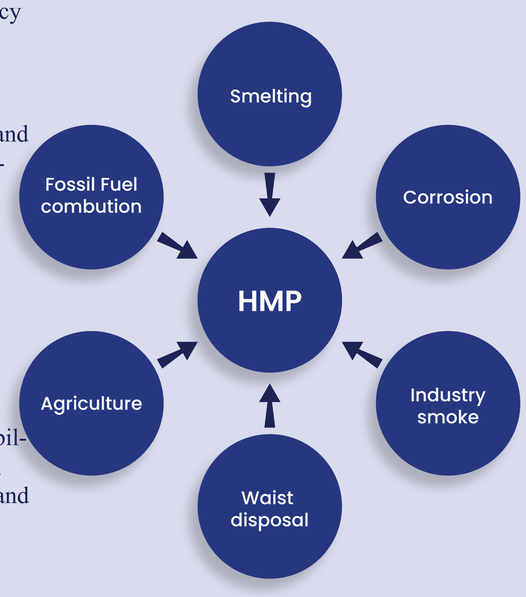
DISCUSSION

Efficiency and Selectivity:
Functionalized MOFs outperformed traditional adsorbents, achieving >99% removal efficiency and 95% selectivity for heavy metals

Sustainability:
MOFs reduced energy consumption by 30% and operational costs by 40%, making them a sustainable alternative to traditional water treatment methods

Scalability:
MOFs maintained >90% efficiency over 10 regeneration cycles

Real-World Application:
The prototype system demonstrated the feasibility of scaling up MOF-based water treatment, with potential applications in both industrial and household settings



CONCLUSION

High Efficiency:
>99% removal of heavy metals (Pb, Hg, As).

Selective Adsorption:
95% selectivity for Pb over competing ions.

Reusability:
Maintains >90% efficiency over 10 cycles.

Energy & Cost Savings:
30% lower energy consumption, 40% cheaper than reverse osmosis.

REFERENCES

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