MOF4AIR:
Metal Organic Frameworks for carbon dioxide Adsorption processes in power production and energy Intensive industRies

General information

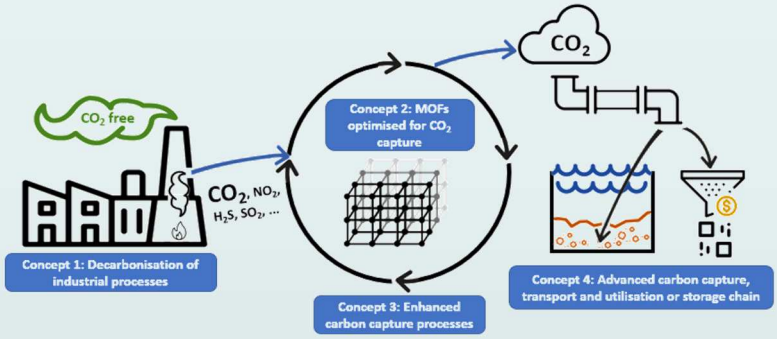
- This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement n° 837975
- Coordinator: University of Mons
- MOF4AIR gathers 14 partners from 8 countries (including South Korea)
- Overall budget: 11 M€
- Duration: 48 months (07/2019 – 06/2023)

Objectives

- Increase the cost effectiveness of CCS and decrease its energy penalty
- Qualify and validate the most promising MOF materials for adsorption-based carbon capture
- Fine-tune adsorption processes for high performance MOFs
- Demonstrate the performance of MOF based carbon adsorption in real operation
- Ensure the technology replication in different CO_2 and energy intensive industries and its sustainability
- Increase stakeholder and public awareness of the challenges, benefits and issues related to carbon capture, transport, use and storage

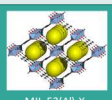
Overall concept of the project

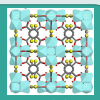
Combine carbon capture processes: VPSA or MBSTA and innovative highly efficient MOFs in a tailored carbon capture solution to energy intensive industries and their varying composition of off-gases including contaminants.



Characteristics of MOF(s) selected for demonstration

- Maximum working capacity above 1 mol.kg^{-1} between 1 bar and 0.1/0.15 bar and 298-323 K
- CO_2/N_2 Selectivity > 30 at 1 bar
- Stable with water, SO_2, NO_x, H_2S (even in presence of water)
- Heat of adsorption below 50 kJ.mol^{-1}

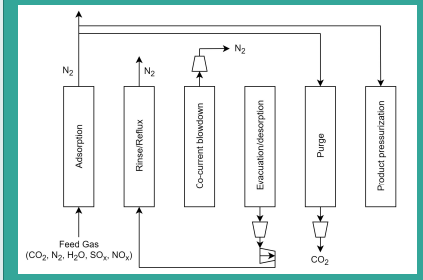

MIL-53(Al)-X


UiO-66 (Zr)-X

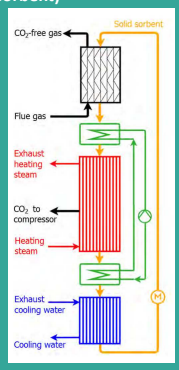

X-MOF-74

MOF4AIR will fine-tune 2 different capture processes that are highly promising for carbon capture in combination with MOFs

VPSA
(using vacuum to regenerate the adsorbent)



MBTSA
(using heating to regenerate adsorbent)

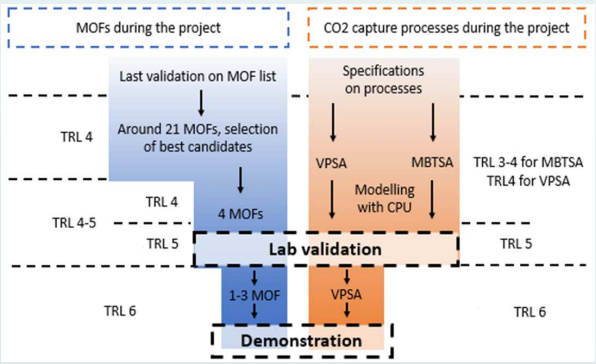


Process optimization and advanced CCU/CCS chains

- The MOF4AIR consortium considers their performant capture solution as one brick of the global carbon chain
- As compressing CO_2 at high CO_2 purity is needed for transport and utilization or storage and requires the use of energy, MOF4AIR will study the best integration of adsorption process with conventionally used CPU
- In addition to the conventional process optimization of stand-alone VPSA/TSA processes, integrated sorption-CPU process configurations will be compared and systematically optimized from the techno-economic point of view using *ad hoc* numerical methods for the optimization of flowsheets and adsorption cycles

MOF4AIR methodology

MOF4AIR consists in parallel developments and TRL upgrades on MOFs and carbon capture processes, leading to a TRL6 demonstration on 3 sites



Demonstration

TCM (Mongstad, Norway)

- RFCC (Residue Fluid Catalytic Cracker – refinery)
- CHP (Combined Heat and Power – power plant)
- 4 major oil companies: GASSNOVA, EQUINOR, SHELL, TOTAL
- One of the most advanced and the largest post-combustion CO_2 capture pilots

TUPRAS (Izmit, Turkey)

- Turkey's largest oil enterprise with 32,5 million m³ crude processing capacity
- 7th largest refinery enterprise in Europe
- Post-combustion flue gases: furnaces, boilers, steam generators, incinerators, FCC regenerators ...

SOLAMAT (Marseille, France)

- Part of Marseille-Fos cluster
- Waste incinerator
- Pipeline collecting CO_2 from different sources and feeding different applications will be soon set up

MOF4AIR Impacts

- MOF4AIR does significant, step-change advances in reductions in energy penalty and thus in the fuel-dependent cost of CO_2 capture, among others by: (i) Producing high performant MOFs; (ii) Proving the performances of the selected capture processes; (iii) Increasing the performances of these CC technologies
- MOF4AIR facilitates the safe and economic integration of CC into industrial clusters - which will lower the barriers to the wider uptake of CCS, in particular for those sectors vulnerable to carbon leakage: (i) Final SPECCA (specific primary energy consumption for CO_2 avoided) for VPSA and MBTSA on all carbon emitting processes studied below 2.5 GJ_{LHV}/t_{CO2}; (ii) Cost of capture for all sectors and sub sectors below 25 €/t_{CO2}; (iii) Energy penalty below 18%; (iv) Incremental cost below 10%
- To prevent CO_2 emissions, MOF4AIR will: (i) Include 4 clusters in its Industrial Cluster Board (ICB); (ii) Consider 10+ industrial sectors in the ICB
- MOF4AIR encourages European leadership by: Fostering Europe as leader in MOF-based CO_2 adsorption
- MOF4AIR will participates to SDGUN 7 and 13 by: (i) Diminishing CO_2 emissions from power plants and carbon intensive industries by 95%; (ii) Diminishing cost increase from power plants with CCS compared to power plants without CCS by 20%

More information

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