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# APPLICATIONS OF METAL-ORGANIC FRAMEWORKS IN VPSA TECHNOLOGY FOR $CO_2$ CAPTURE

## INTRODUCTION

One of the technologies that may find application in the reduction of $CO_2$ emissions from both energy and other industrial plants is the adsorption method. Among all adsorption techniques, the Vacuum Pressure Swing Adsorption (VPSA) technology, seem to be the most effective for the separation of $CO_2$ from flue gases, because the flue gas is at low pressure. The most important step in the design of a VPSA plant is the selection of the adsorbent. Currently, only activated carbons and zeolites can be used for a large-scale plant VPSA, but the list of adsorbents proposed and tested for being used in VPSA systems is definitely larger. It includes molecular sieves, organic polymers, amine-modified microporous sorbents and metal-organic frameworks MOF$_{s.}$ Due to very high sorption capacity of some MOFs compared to zeolites and activated carbons, these compounds are mentioned as potentially the best adsorbents for VPSA systems. A limitation is the lack of knowledge regarding the behaviour of these compounds in actual VPSA systems and a considerable cost at the present stage of their development [1-2]. In order to evaluate the possibility of using metal-organic frameworks, besides zeolites and activated carbons, for $CO_2$ adsorption in large-scale VPSA units, investigations of these compounds in bench-scale and pilot VPSA adsorption units are necessary.

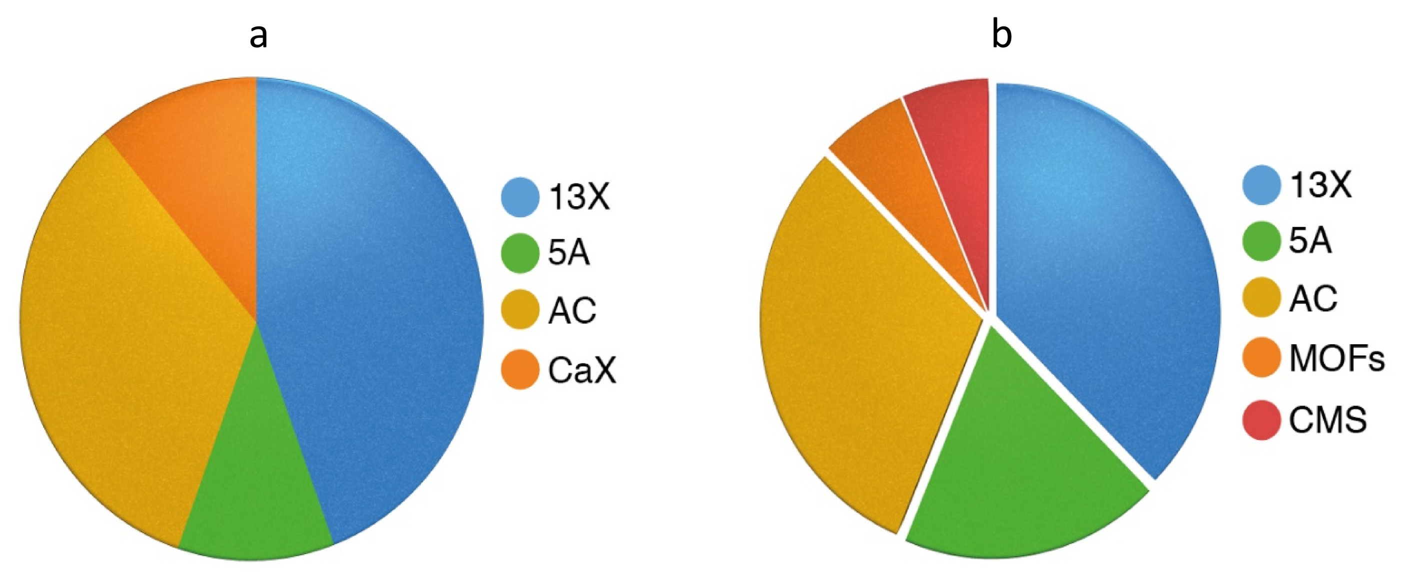


Fig.1 Solid adsorbents used in VSA/VPSA units: a) pilot $CO_2$ capture units, b) laboratory $CO_2$ capture units


Fig.2 Adorbents proposed in the VSA/VPSA adsorption technology: a) activated carbon, b) MIL-53(Al) metal-organic framework, c) CuBTC metal-organic framework, d) zeolite 13X.

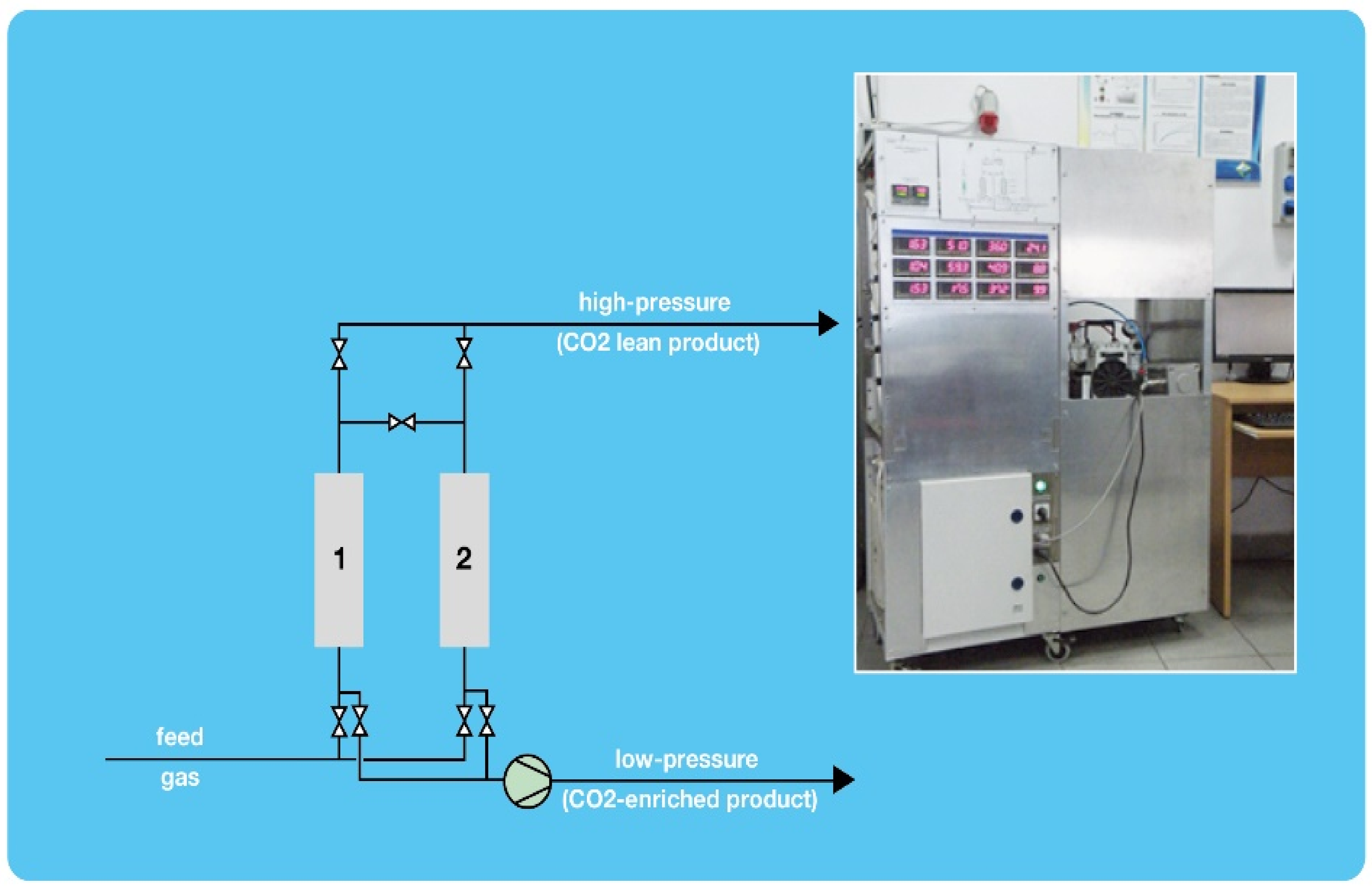


Fig.3 Schematic diagram and a view of the VPSA installation

Table 1 VSA process parameters (feed gas:16% $CO_2$, 3.5% $O_2$, 80.5% $N_2$)

| | | |
|---|---|---|
| Adsorption pressure | [mbar abs] | 1250 |
| Desorption pressure | [mbar abs] | 200 |
| | | 100 |
| Feed gas stream | [cm3/g] | 150 |
| | | 300 |
| | | 600 |
| | | 900 |
| Adsorption duration | [s] | 1200 |
| | | 1500 |
| | | 1800 |
| Adsorption stage temp. | [°C] | 30 |
| Regeneration stage temp. | [°C] | 30 |

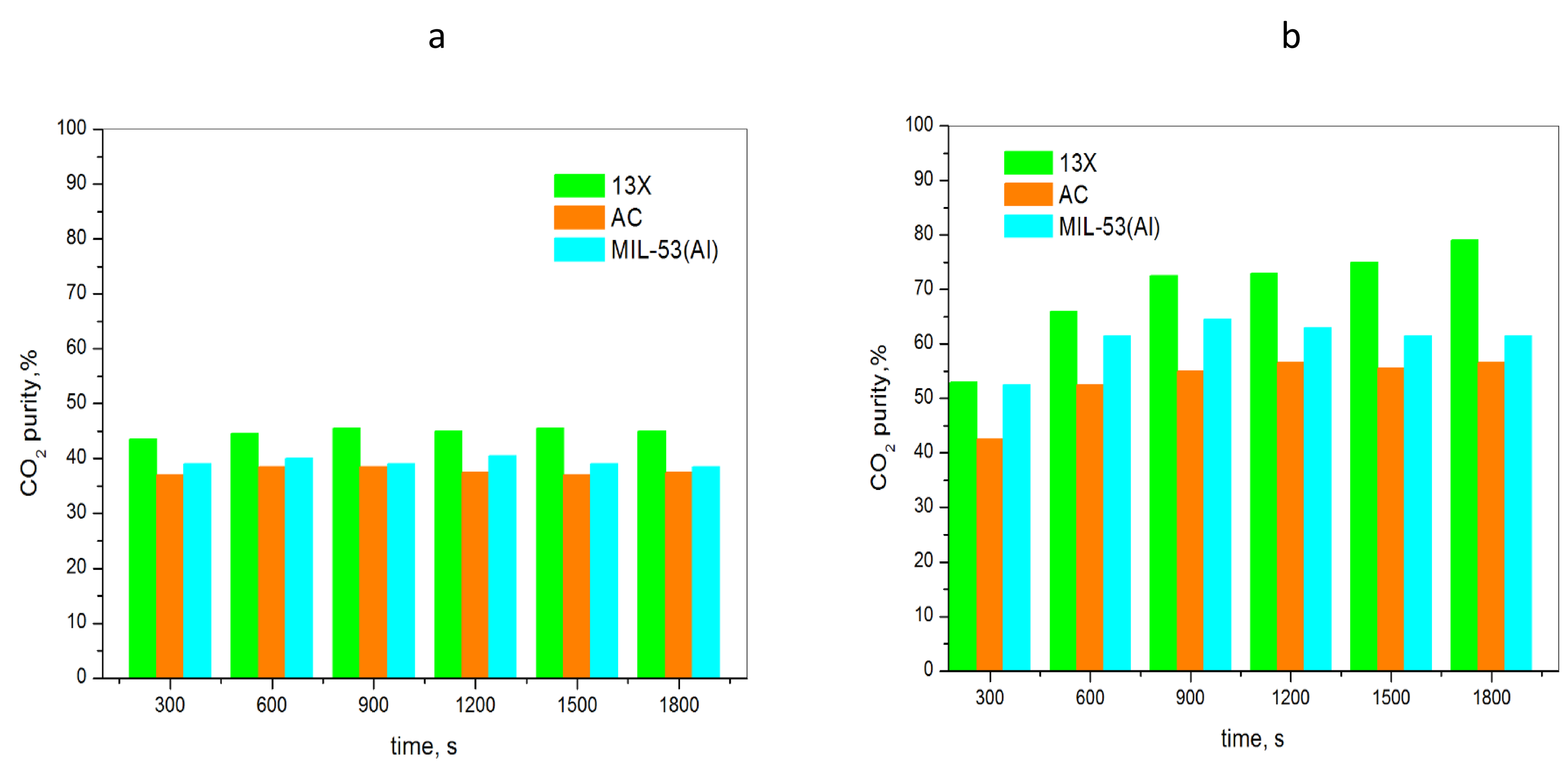


Fig.4 The effect of adsorption/regeneration time on $CO_2$ purity) with a desorption pressure of: (a) 200mbar, and (b) 100mbar, for different physical adsorbents

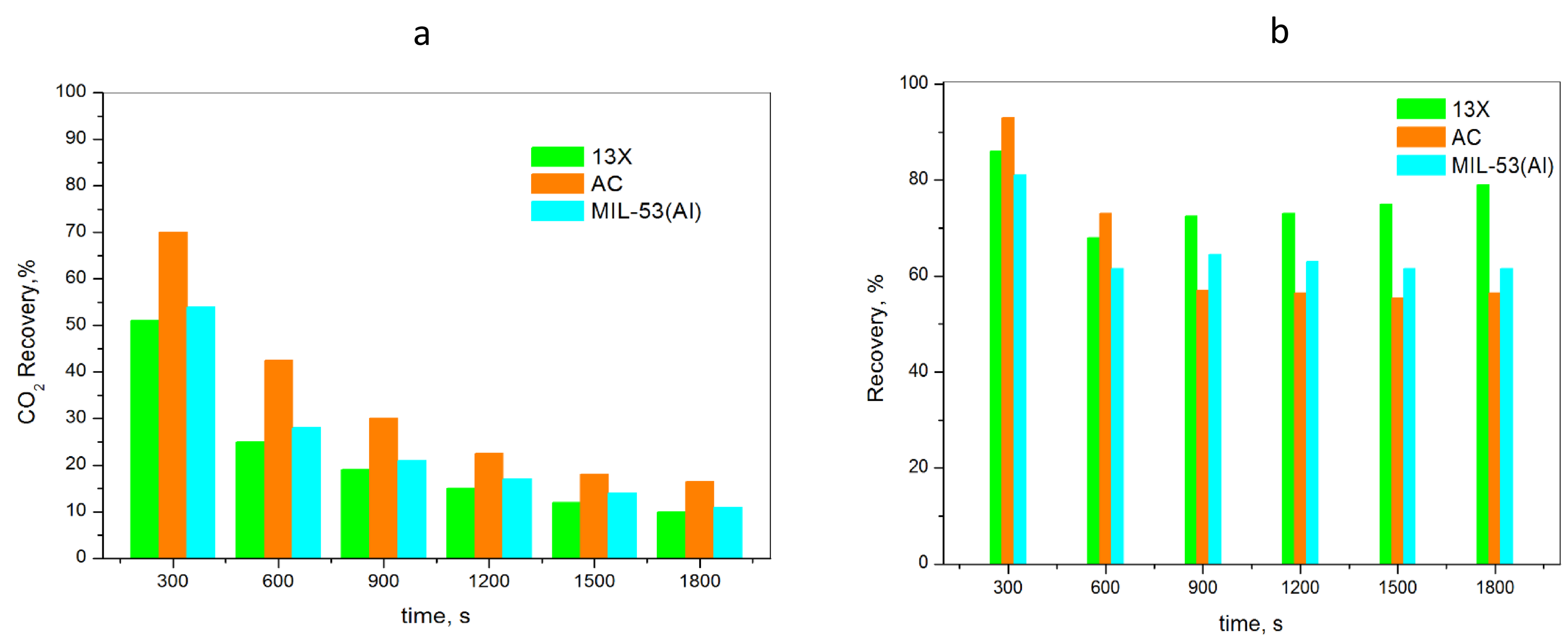


Fig. 5 The effect of adsorption/regeneration time on the rate of $CO_2$ recovery from the feed gas at a desorption pressure of: (a) 200mbar, and (b) 100mbar for different types of physical adsorbents.

## CONCLUSION

The investigation carried out has demonstrated that the metal-organic frameworks can be effectively pelletized without losing its sorption properties, and can be used as a bed in the process of carbon dioxide separation from combustion gas by the vacuum-pressure swing adsorption (VPSA) method.

The most essential from the point of view of the future use of MOFs as adsorption column packing in VPSA CO capture units is to verify their potential in a bench-scale VPSA installation. The obtained data confirm the potential of these compounds and indicate the need for further pilot tests in pilot VPSA units under real combustion gas conditions. This is especially challenging because of the need for synthesizing considerable amounts of these compounds, which are currently produced, in most cases, only in gram quantities.


## REFERENCES

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