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Unusually Low heat of Adsorption of CO_2 on AlPO and SAPO Molecular Sieves

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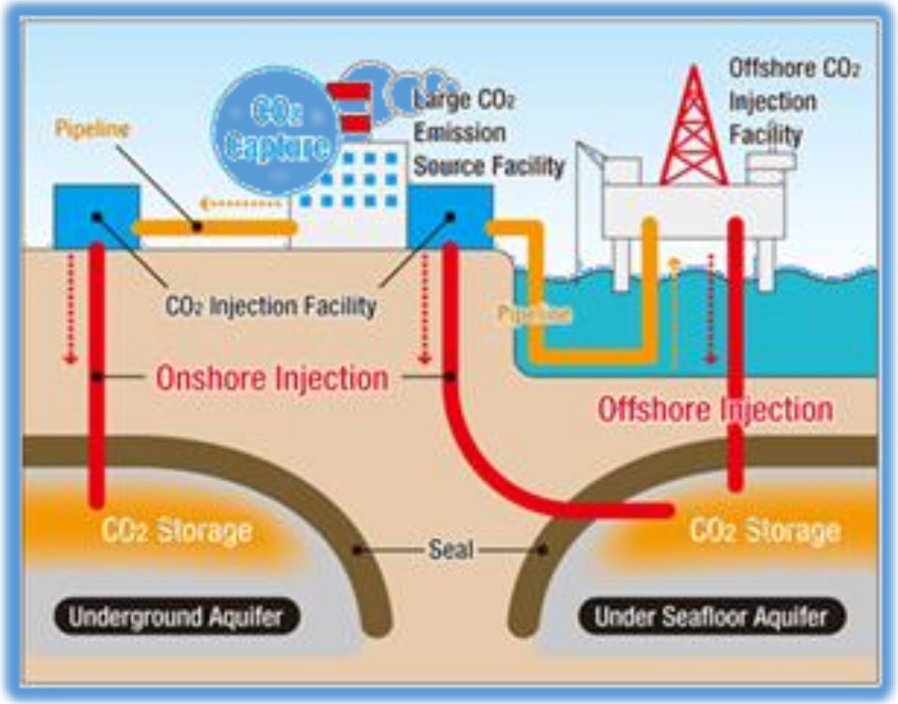
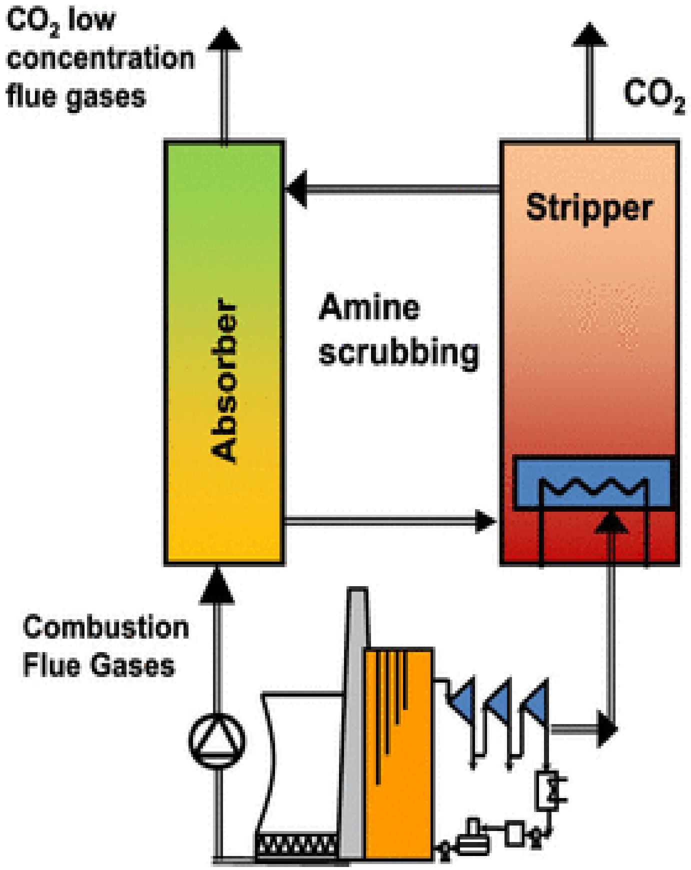
INTRODUCTION

To mitigate CO_2 emissions and prevent the negative effect they have on climate change, **Carbon Capture and Storage (CCS)** technologies are being applied and developed.



The most common technology for CCS from large point sources is **Amine Scrubbing.**



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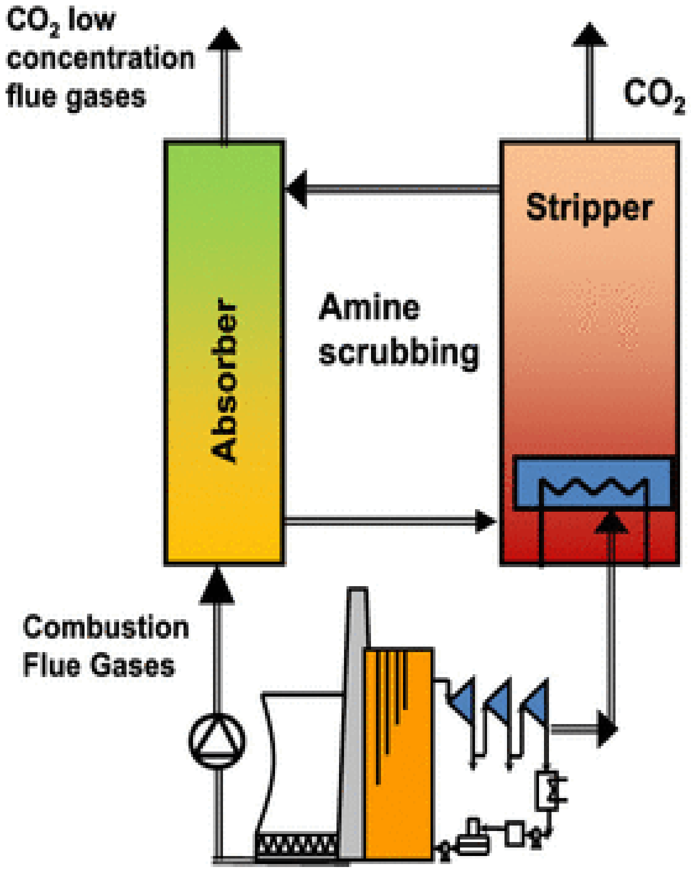
High selectivity

High recovery

Well-established



Highly energy demanding process

Reactant stability

Corrosion of the equipment

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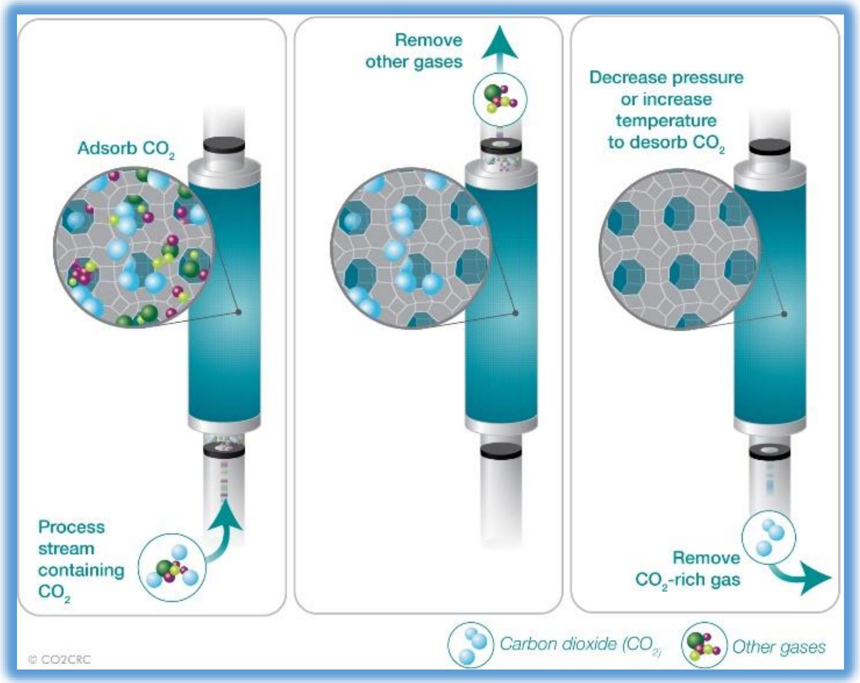
SEPARATION BY ADSORPTION

Adsorbents materials for CO_2:

- Carbonaceous materials
- Metal Organic Frameworks (MOFs)
- Covalent Organic Frameworks (COFs)
- Supported Amines
- Zeolites
- **Aluminophosphates and Silicoaluminophosphates**



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- Selectivity
- Working capacity
- Easiness of regeneration

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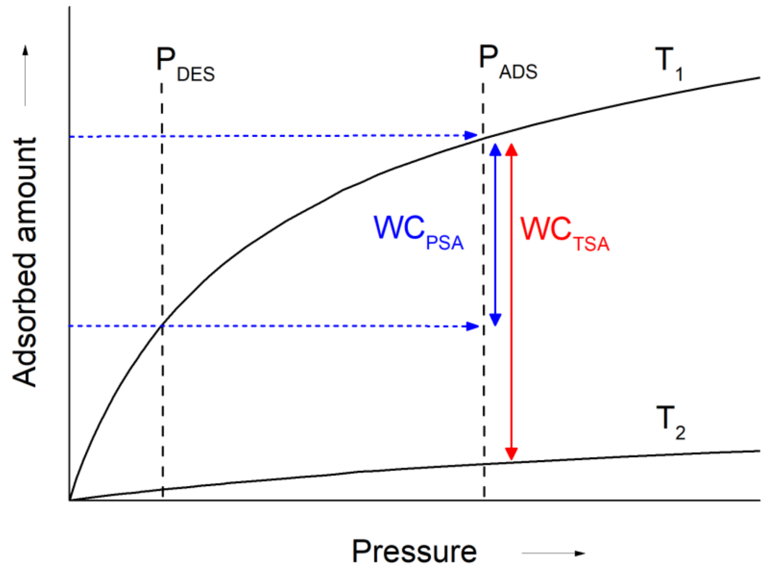

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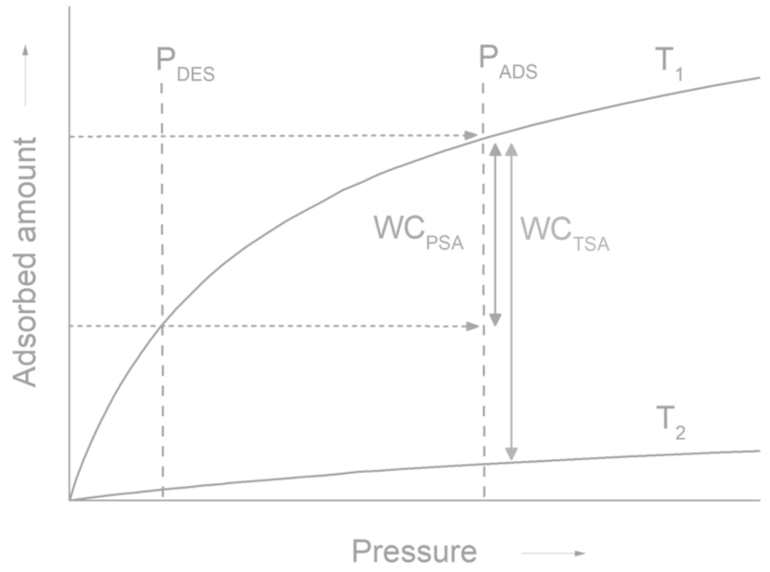
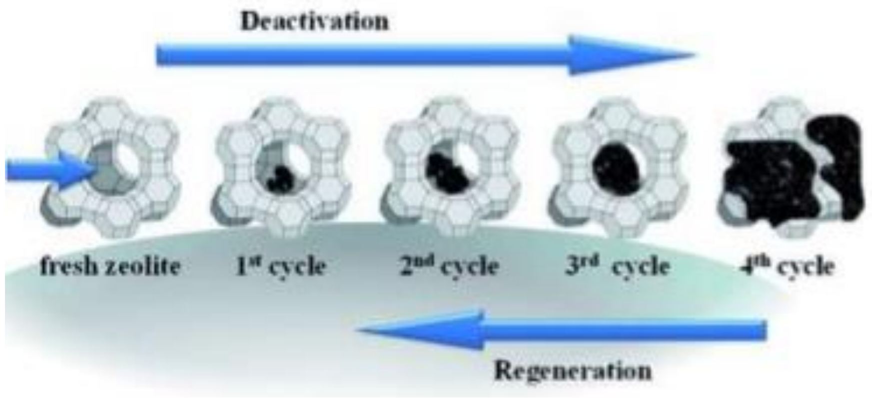


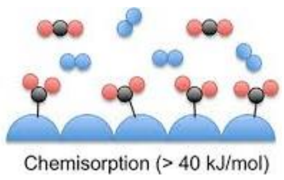
- Working Capacity

- **Easiness of Regeneration**



Chemical interaction with CO_2 :

- Supported Amines
- MOFs
- Low silica zeolites



- ➢ High selectivity of CO_2/CH_4 and CO_2/N_2
- ➢ High energy of regeneration

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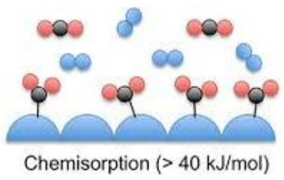

- High selectivity of CO_2/CH_4 and CO_2/N_2
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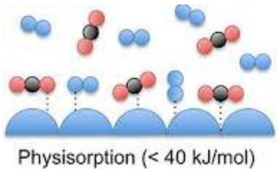
Physisorption interaction with CO_2 :

- Carbonaceous
- MOFs
- High silica zeolites
- AlPOs and SAPOs



- Selectivity of CO_2/CH_4 and CO_2/N_2 can be high
- Lower energy of regeneration
- Higher working capacity

OBJECTIVES

1. Heat of Adsorption of CO_2 on AlPOs an SAPOs and compare with the zeolitic counterparts.

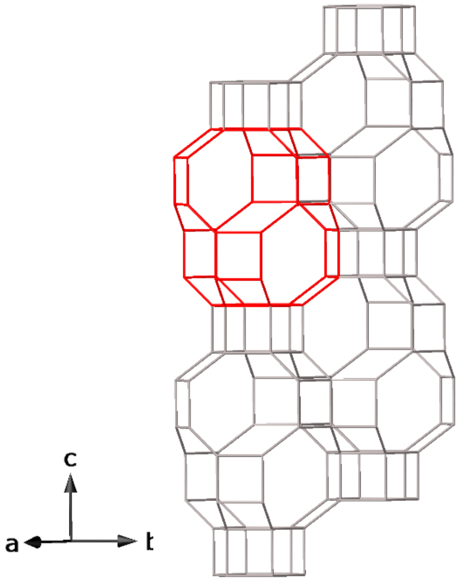
2. Dependence of the Heat of Adsorption with the Framework Negative Charge.

3. Trend of the Heat of Adsorption with the Selectivity of CO_2/CH_4.

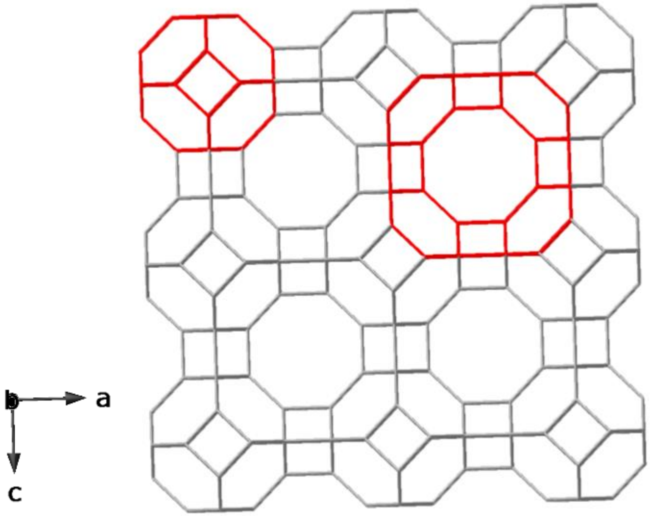
Small Pore Structure

Large Pore Structure

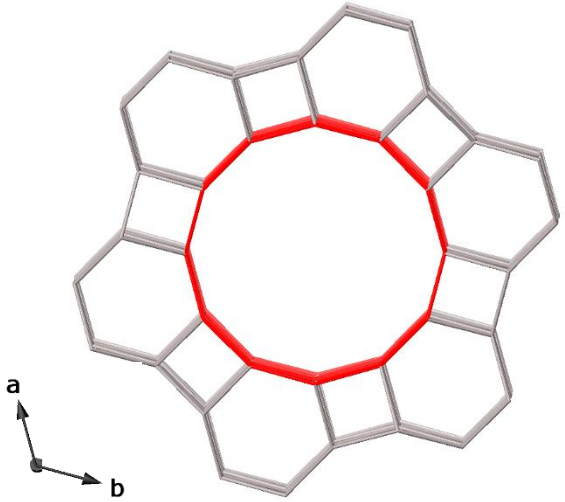
CHA



LTA



AFI



ISOTHERMS OF CO_2 ADSORPTION

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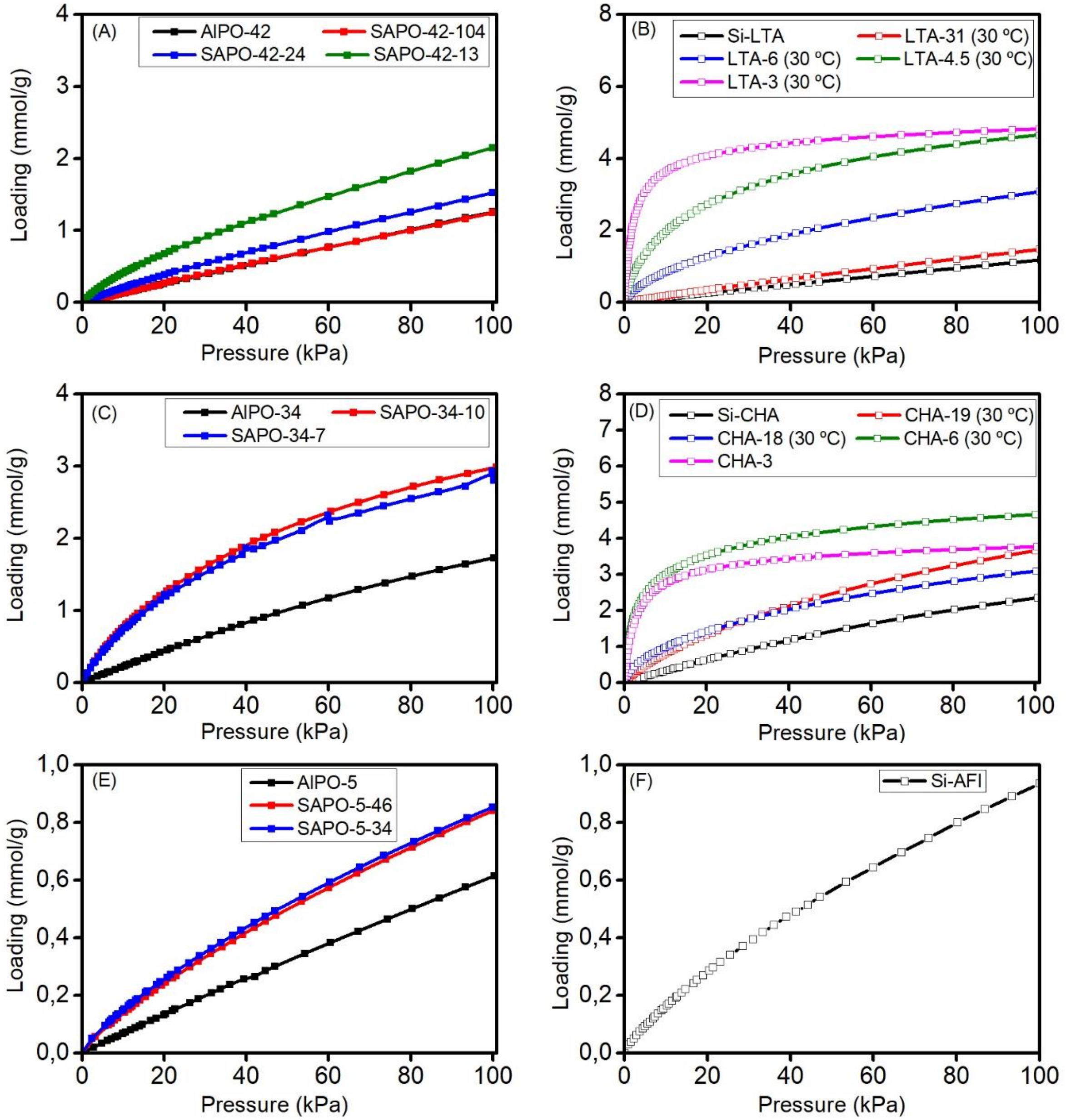
ALPOs and SAPOs | **ZEOLITES**

LTA

CHA

AFI



AlPOs and SAPOs present similar isotherms to high Si/Al zeolites and reach the saturation at higher pressures than low Si/Al Zeolites

ISOSTERIC HEAT OF ADSORPTION OF CO_2

ALPOs and SAPOs | **ZEOLITES**

LTA

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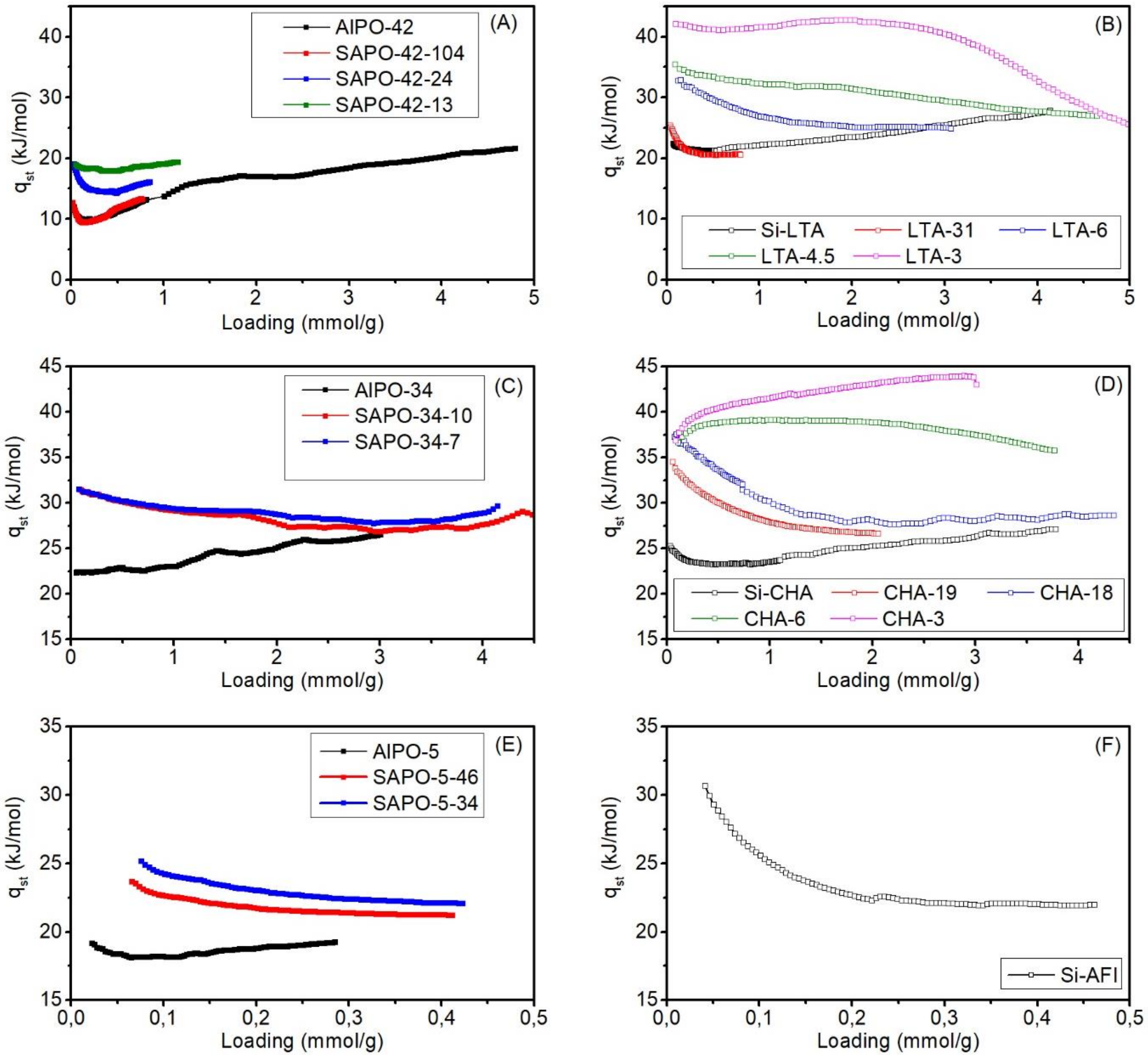
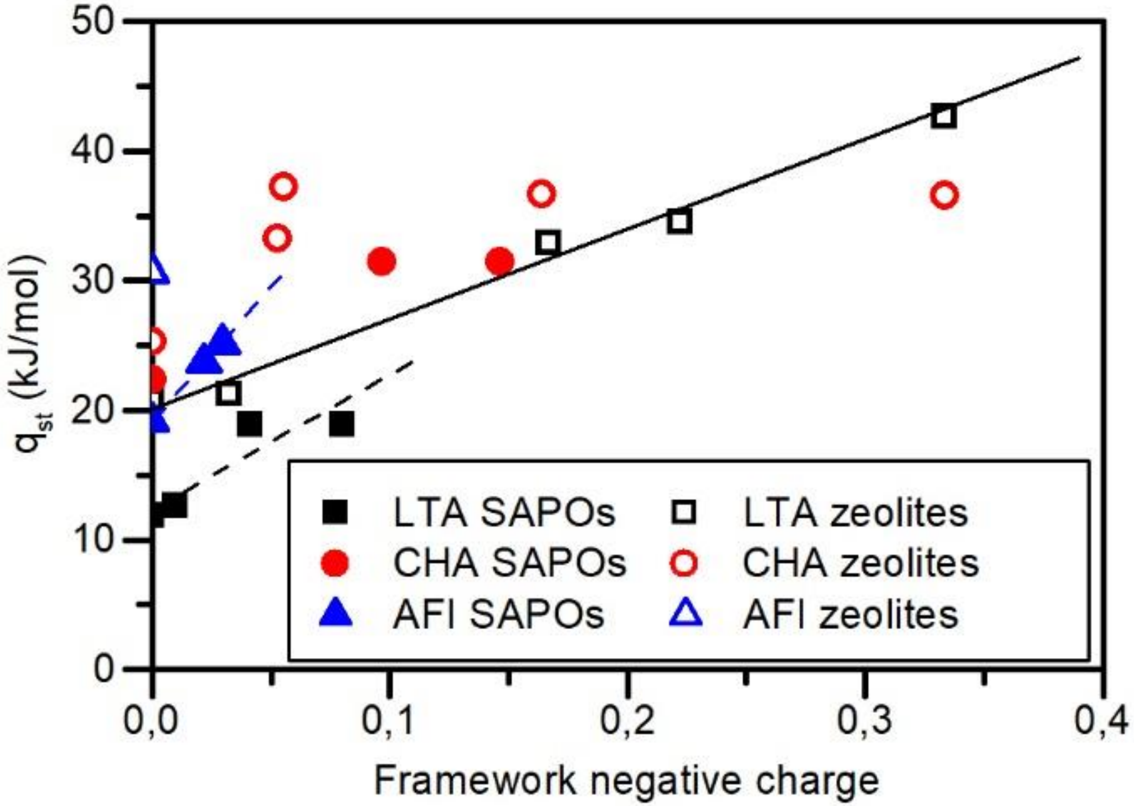


The value of the heats of adsorption at low loading give information about the affinity adsorbent-CO_2

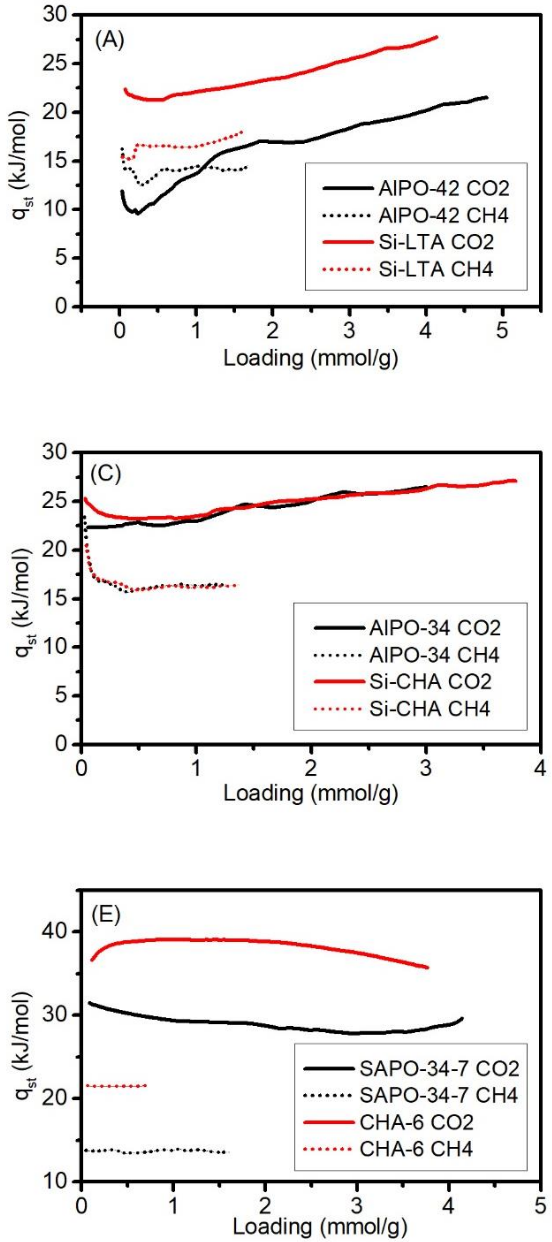
ISOSTERIC HEAT OF ADSORPTION OF CO_2



- AlPOs and SAPOs with **LTA and AFI** structure show lower q_{st} than the analogous zeolites.
- Lower q_{st} of adsorption results in an easy regeneration

Palomino et al. 2010

COMPARISON IN TERMS OF CO_2 AND CH_4 ADSORPTION



- Lower q_{st} of CO_2 and CH_4 on AlPOs and SAPOs

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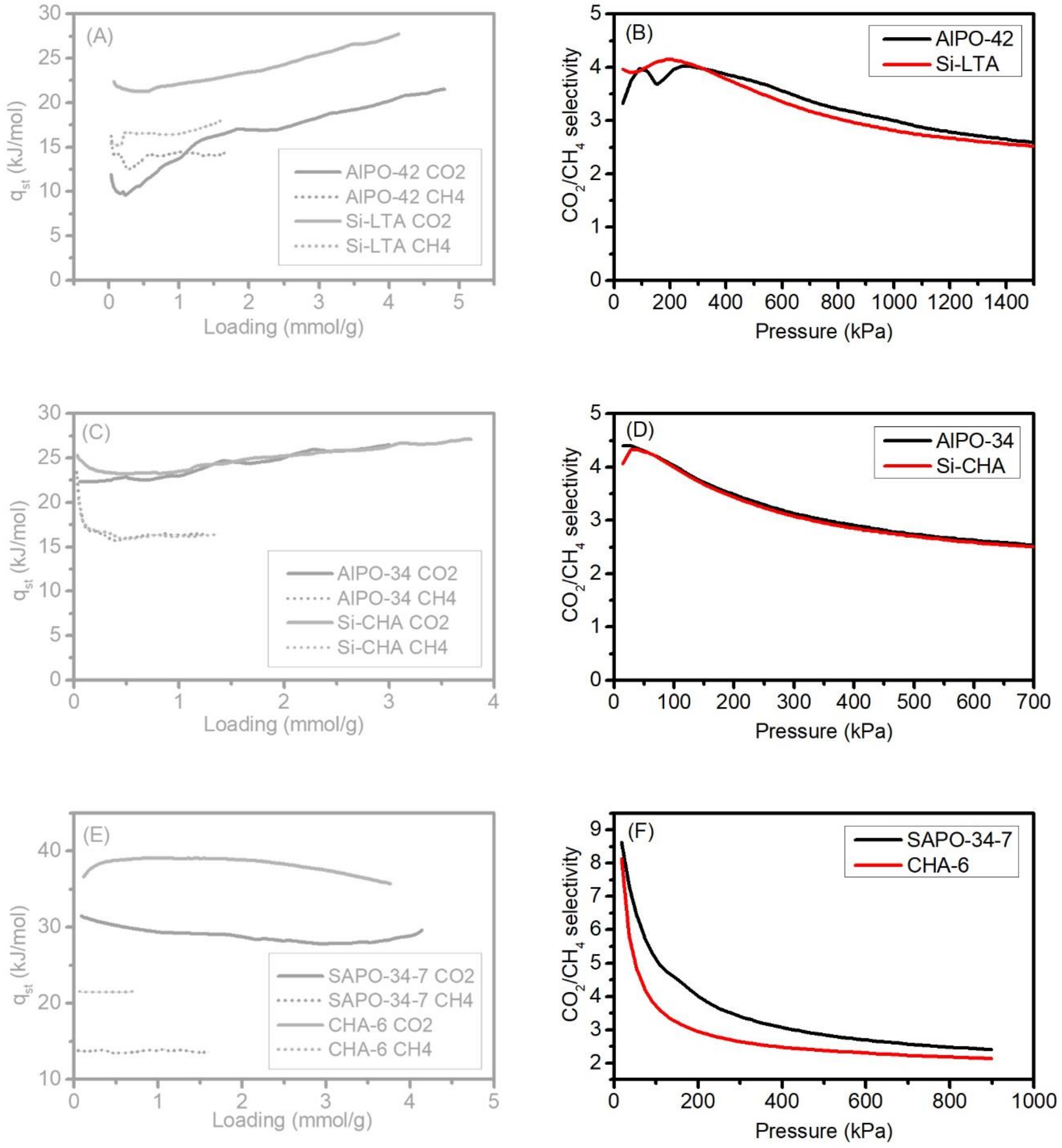

- Lower q_{st} of CO_2 and CH_4 on AlPOs and SAPOs
- Similar selectivity to CO_2/CH_4

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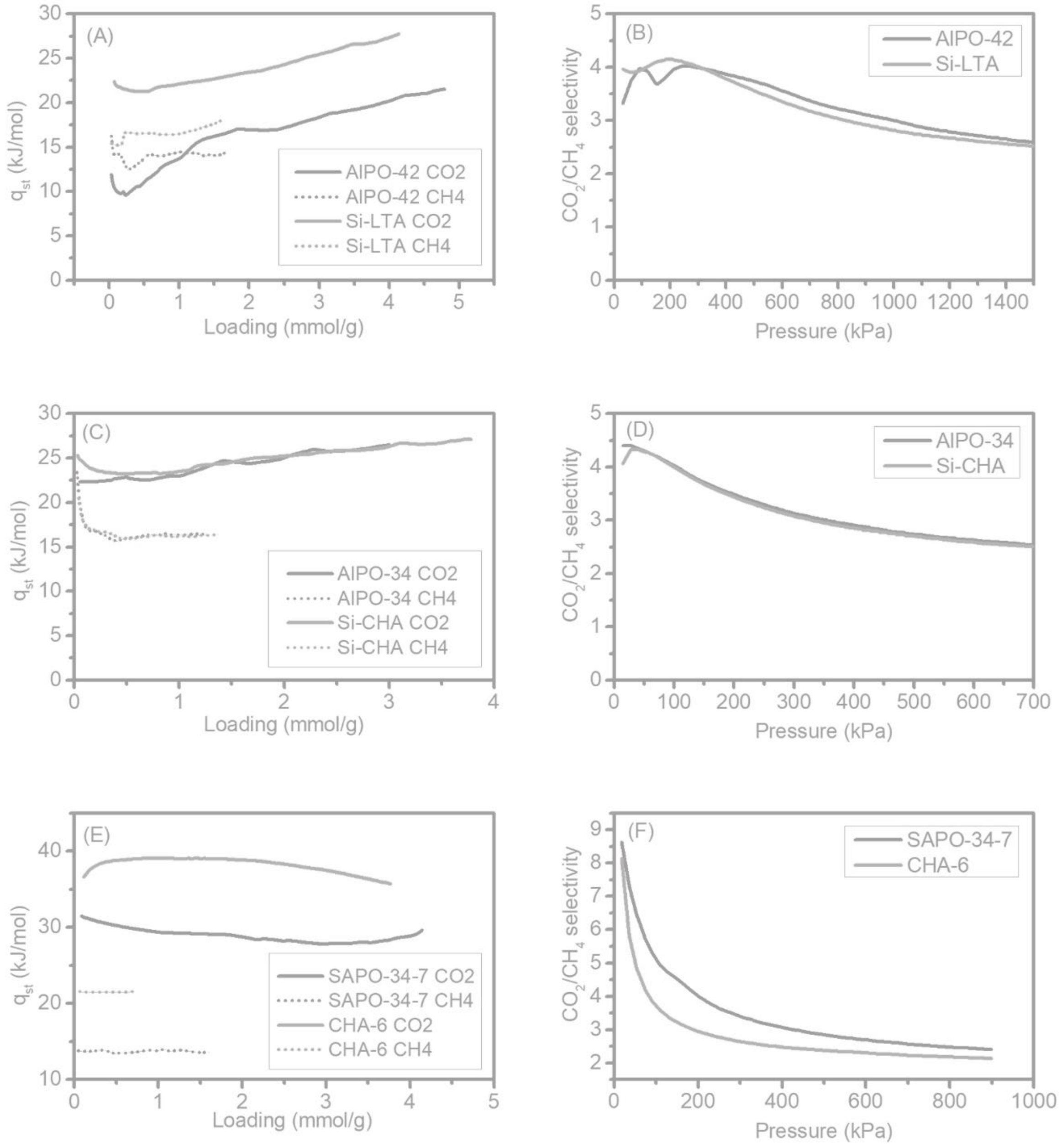

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	Working capacity (mmol/g)
AlPO-42	3.21
Si-LTA	2.99
AlPO-34	1.90
Si-CHA	2.38
SAPO-34-7	1.84
CHA-6	1.01

CONCLUSIONS

- The isosteric heat of adsorption of CO_2 on AlPOs and SAPOs with AFI, LTA and CHA structures are lower than on the isostructural zeolites, even of pure silica composition.

- These results suggest that AlPOs and SAPOs can present major advantages in the field of CO_2 separation and adsorption in comparison to zeolites, if materials with structures that maximize selectivities over CH_4 or N_2 are found.

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For Your Attention