

# Comparing zeolite adsorption properties in cultural heritage contexts



SWEDISH NATIONAL HERITAGE BOARD  
RIKSANTIKVARIÉÄMBETET

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## Purpose

To investigate the adsorption of acetic acid gas by zeolites and activated carbon.

## Importance

Acetic acid gas is harmful to museum objects but its reduction by adsorption is not well studied.

Little research exists on how different zeolites function in museum environments (low pollutant concentrations, low airflow, moderate humidity).



Photos by Elyse Canosa, RAÄ

## Properties of the investigated adsorbents:

Adsorbent	Pore size	Polarity	Particle diameter
Zeolite Type 4A	4 Å	Polar	1 - 2 mm
Zeolite Type 5A	5 Å	Polar	1 - 2 mm
Zeolite Type 13X	10 Å	Polar	1 - 2 mm
Granular activated carbon	10 – 25 Å	Nonpolar	2.4 - 4.8 mm

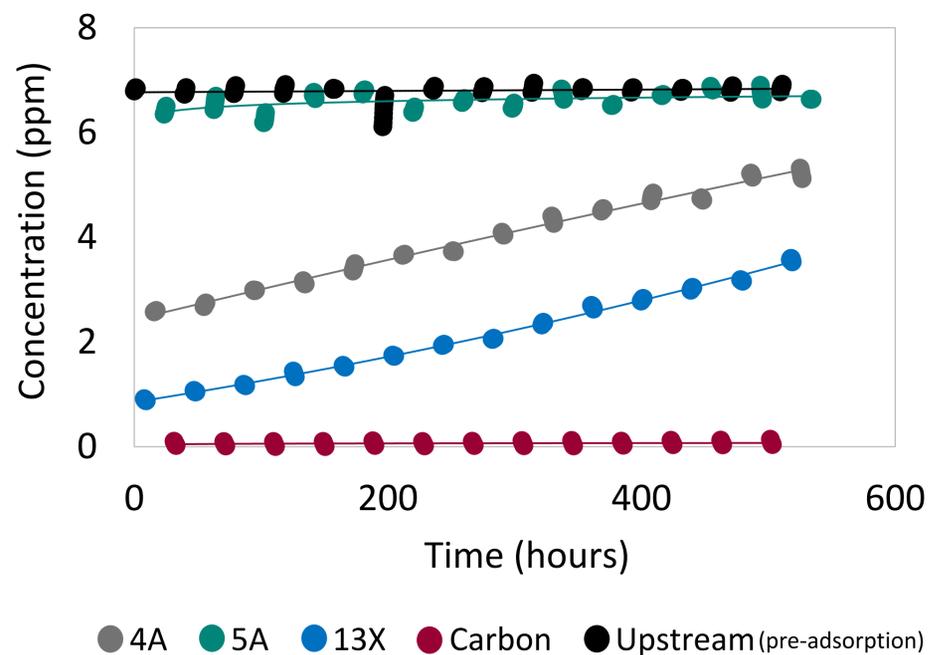
## Active adsorption - forced airflow

Acetic acid (6.8 ppm) forced through adsorbent bed (26 mm deep).

Concentration measured upstream (before adsorption) and downstream (after adsorption) using a flame ionization detector.

Relative humidity: 54%,  
Temperature: 22 °C,  
Airflow: 1.8 m<sup>3</sup>/h,  
Contact time: 0.1 s

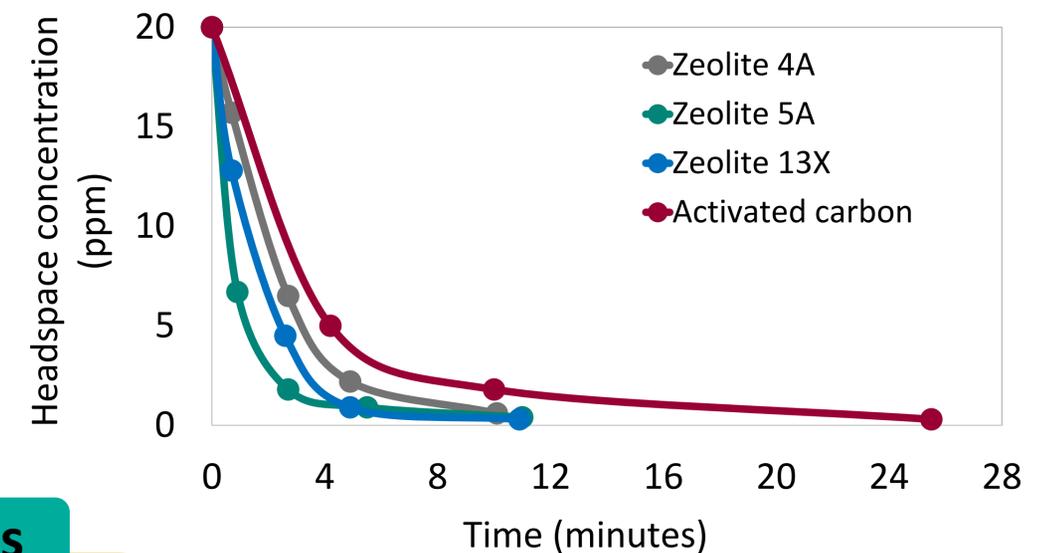
### Downstream acetic acid concentrations



## Passive adsorption – no forced airflow

- Headspace gas chromatography – mass spectrometry
- 8 mg adsorbent in 20 mL headspace vial, one control vial
- 50% RH, 23 °C, no forced airflow
- Data accounts for acetic acid adsorption on vial walls

## Uptake kinetics of 20 ppm acetic acid:



## Conclusions

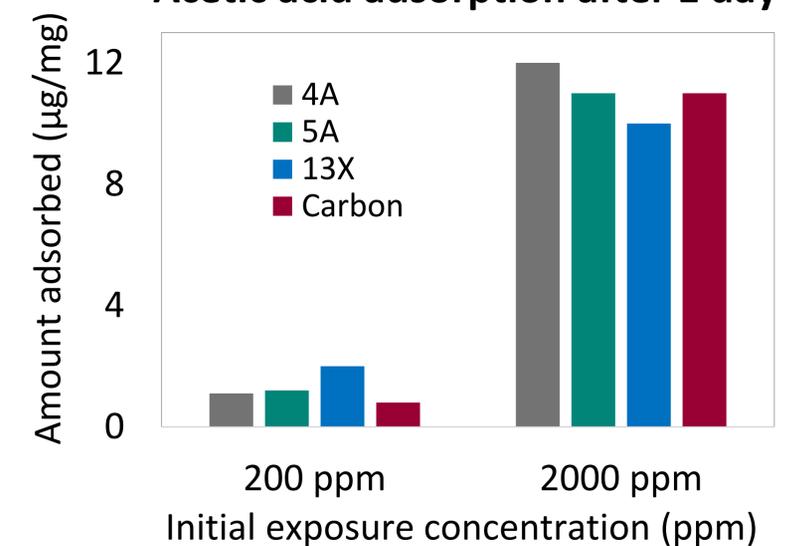
Zeolites less effective than carbon during active adsorption, but had faster uptake rates during passive adsorption.

All adsorbents passively adsorbed similar amounts of acetic acid after 1 day.

Type 13X was the most effective of all zeolites.

**Possible future work:** determine capacity and isotherms for the adsorbents.

## Acetic acid adsorption after 1 day



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