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Data Article

# Dataset on the comparison of synthesized and commercial zeolites for potential solar adsorption refrigerating system

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A B S T R A C T

The purpose of this dataset is to provide a comparison between synthesized and commercial 4A and 13X type zeolites. Metakaolin produced from the calcination of beneficiated kaolin at 750 °C for 4 h was dealuminated using sulphuric acid to get the required silica to alumina ratio for the zeolite synthesis. Zeolite 4A and 13X samples were characterized along-side with the commercial variants using X-ray fluorescence (XRF), X-ray diffraction (XRD), Brunauer, Emmett and Teller (BET) and scanning electron microscopy (SEM) techniques. These analyses revealed that, the zeolites synthesized are of comparatively acceptable quality. The pore size of 120.859 nm, pore volume of 0.0065 $cm^3/g$ and surface area of 22 $m^2/g$ were obtained from BET analyses for zeolite 4A synthesized from kaolin, while the commercial zeolite 4A used as control gave pore size of 58.143 nm, pore volume of 0.2462 $cm^3/g$ and surface area of 559.13 $m^2/g$. In the same vein, the pore size of 10.5059 nm, pore volume of 0.135847 $cm^3/g$ and surface area of 324.584 $m^2/g$ were obtained from BET analyses for zeolite 13X

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synthesized from kaolin, while the commercial zeolite 13X gave pore size of 7.2752 nm, pore volume of 0.135951 $cm^3/g$ and surface area of 310.0906 $m^2/g$.



**Specifications Table**

| | |
|---|---|
| Subject area | Engineering |
| More specific subject area | Adsorbents in a solar adsorption cooling system |
| Subject area | Tables and Figures |
| How data was acquired | XRF, XRD, SEM and BET techniques |
| Data format | raw values of XRF and BET, images and patterns of SEM and XRD |
| Experimental factors | 1. Beneficiation to remove impurities from Kankara Kaolin. 2. Calcination of beneficiated kaolin at 750 °C for 4 h to produce metakaolin. 3. Dealumination of metakaolin 4. Gel formation and aging 5. Crystallization of aged product in an oven. 6. Analytical experimentation of synthesized and commercial 4A and 13X type zeolites |
| Experimental features | Metakaolin was produced from the calcination of beneficiated kaolin at 750 °C for 4 h and was dealuminated using sulphuric acid (96 wt/vol%) to get the required silica to alumina ratio for the zeolite synthesis. |
| Data source location | Department of Mechanical Engineering Ahmadu Bello University, Zaria, Nigeria. |
| Data accessibility | Data is available within this article |

**Value of data**

- It is important to promote the local content, hence a need to compare zeolites synthesized from locally sourced clay and commercial zeolites. This will ascertain if local production of the zeolites is to be encouraged.
- The comparison of the zeolites (synthesized and commercial) in terms of the crystallinity and structure, elemental composition and morphology elucidated by XRD, XRF and SEM are of great importance.
- Pore sizes, volumes and specific surface areas further highlighted the potential application of the synthesized zeolites 4A and 13X as compared to the commercial zeolites 4A and 13X for continuous adsorption cooling systems.

## 1. Data

The dataset presented in this paper for XRD as shown in Figs. 2 and 3 is the text file format plotted for the locally synthesized and commercial zeolites. The morphology of zeolites presented in Figs. 4 and 5 is at a magnification of 10.0 kx for locally synthesized and commercial zeolites (4A and 13X). The XRF (Tables 1 and 2) and BET data (Tables 3 and 4) presented are elemental composition and surface area analysis results for locally synthesized and commercial zeolites respectively.

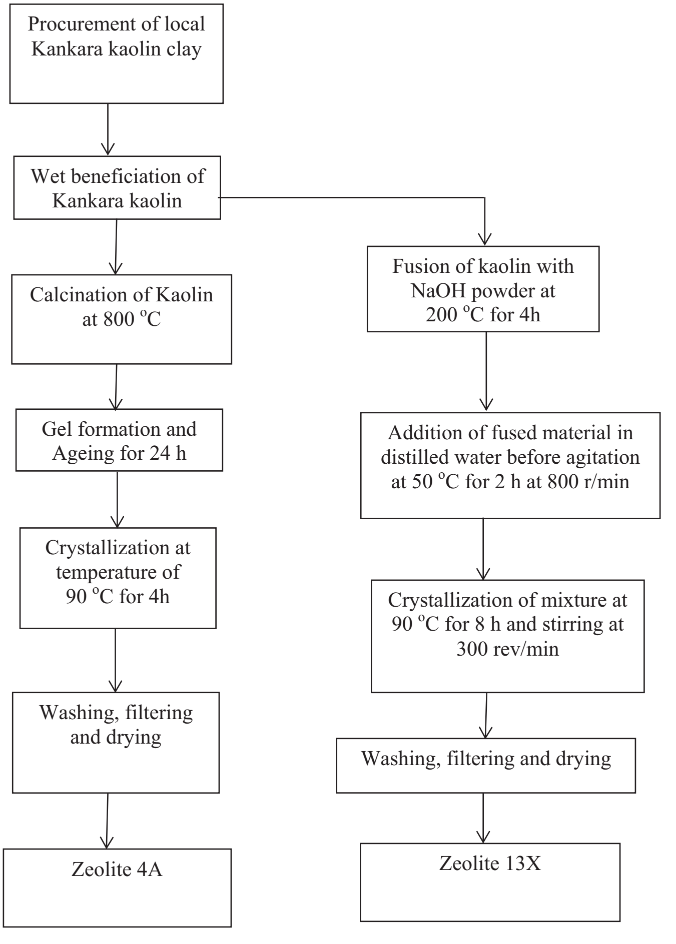


**Fig. 1.** Flow diagram of the synthesis of Zeolites 4A and 13X from Kankara Kaolin.

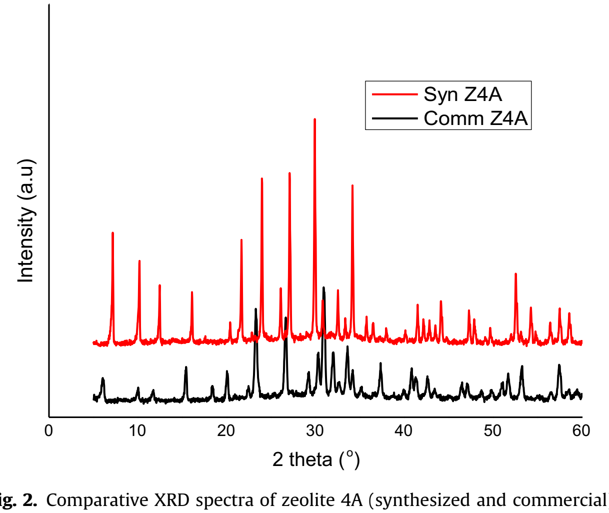


**Fig. 2.** Comparative XRD spectra of zeolite 4A (synthesized and commercial).

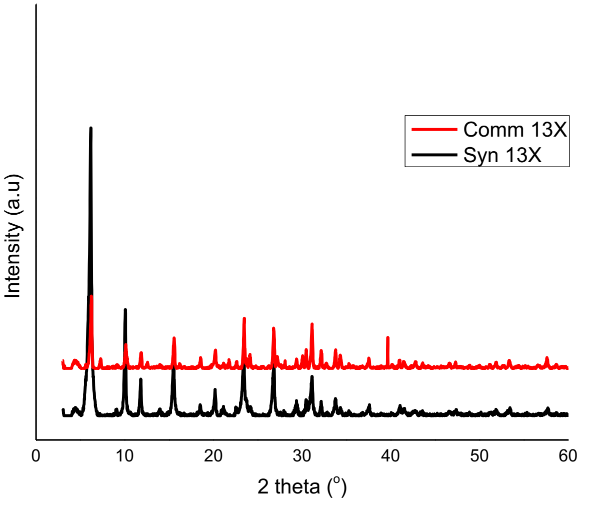


**Fig. 3.** Comparative XRD spectra of zeolite 13X(synthesized and commercial).

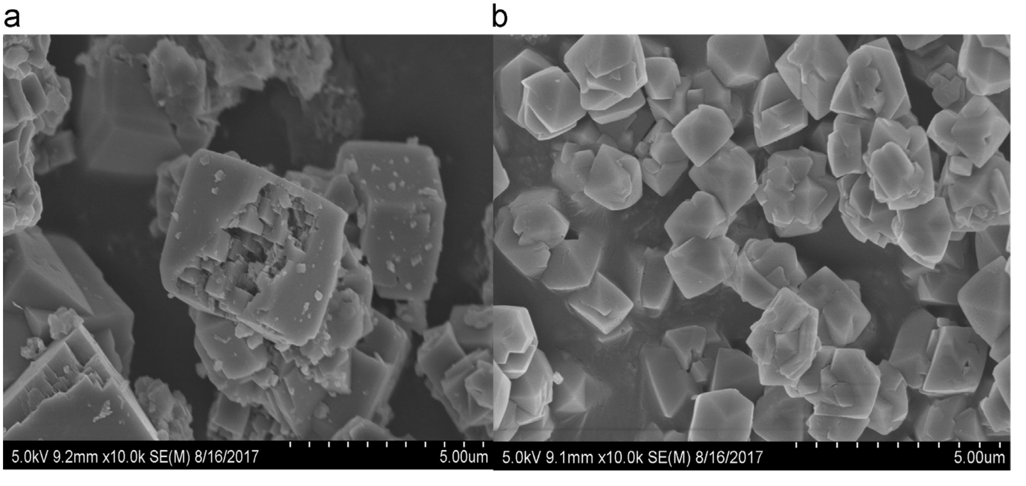


**Fig. 4.** SEM micrograph of (a) zeolite 4A from Kankara kaolin (b) commercial zeolite 4A.

## 2. Experimental design, materials, and methods

A schematic of the experimental procedure of locally synthesized zeolite 4A and 13X is presented in Fig. 1 [1].

XRD patterns of the zeolites (synthesized and commercial) were collected on an Empyrean diffractometer (PANalytical BV, Netherlands) with theta/theta geometry, operating a Cu Kα radiation tube ($\lambda = 1.5418$ Å) at 40 kV and 45 mA. The XRD patterns of all the randomly oriented powder specimens were recorded in the 5.0– 60° $2\theta$ range with a step size of 0.017° and a counting time of 14 s per step. The surface morphology of the zeolites (synthesized and commercial; 4A and 13 × ) was carried out on an ultra-high vacuum and high resolution MAIA3 TESCAN scanning electron microscope operated at 15 kV. In addition, the zeolite samples were analyzed using a Micrometrics TriStar 3000 gas adsorption instrument which calculated the BET surface area. The surface area of the

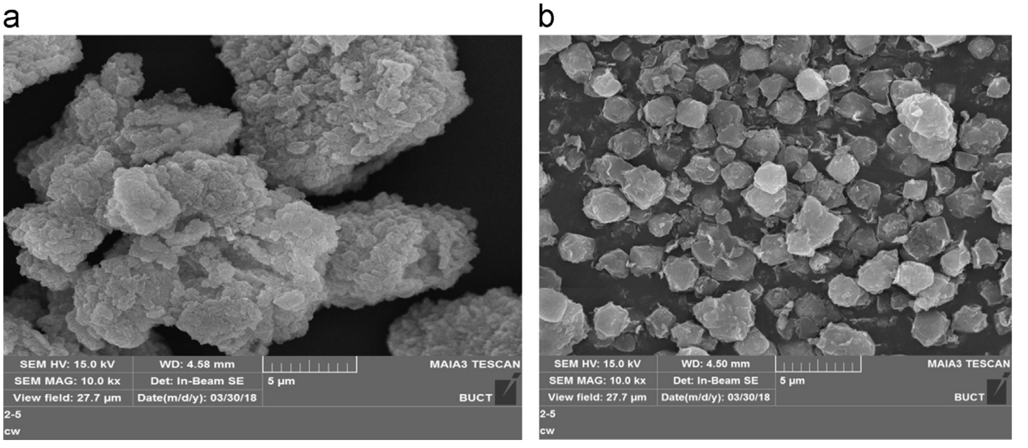


**Fig. 5.** SEM micrograph of (a) zeolite 13X from Kankara kaolin (b) commercial zeolite 13X.

**Table 1**
Elemental composition of zeolite 4A from kaolin, commercial zeolite 4A and reference zeolite 4A.

| Composition (wt%) | Syn 4A | Comm 4A | Reference 4A |
|---|---|---|---|
| $Na_2O$ | 13.777 | 12.601 | 12.60 |
| MgO | 0.316 | 0.215 | 0.23 |
| $SiO_2$ | 49.719 | 55.695 | 35.90 |
| $Al_2O_3$ | 34.673 | 30.645 | 31.19 |
| $K_2O$ | 0.187 | 0.239 | 0.400 |
| $TiO_2$ | 0.039 | 0.013 | 2.01 |
| $Fe_2O_3$ | 0.664 | 0.059 | 1.13 |
| **Si/Al** | 2.440 | 3.090 | 2.000 |

Syn-synthesized; Comm-commercial; Reference zeolite 4A [3]; Si/Al – silica/alumina ratio.

**Table 2**
Elemental composition of zeolite 13X from kaolin, commercial zeolite 13X and reference zeolite 13X.

| Composition (wt%) | Syn 13x | Comm 13X | Reference 13X |
|---|---|---|---|
| $Na_2O$ | 9.757 | 15.930 | 12.49 |
| MgO | 0.502 | 0.8035 | ND |
| $SiO_2$ | 55.099 | 53.7975 | 49.28 |
| $Al_2O_3$ | 30.180 | 28.580 | 30.17 |
| $K_2O$ | 0.400 | 0.0360 | ND |
| $TiO_2$ | 0.069 | 0.3660 | ND |
| $Fe_2O_3$ | 0.836 | 2.080 | ND |
| Si/Al | 3.110 | 3.200 | 2.770 |

ND: Not detected; Syn-synthesized; Comm-commercial; Reference zeolite; Reference 13X – [4]. Si/Al – silica/alumina ratio.

**Table 3**
BET data of synthesized and commercial zeolite 4A.

| BET analyses | Syn 4A | Comm 4A |
|---|---|---|
| Pore size (nm) | 12.086 | 58.143 |
| Specific surface area ($m^2/g$) | 22 | 559.13 |
| Pore volume ($cm^3/g$) | 0.0065 | 0.2462 |

**Table 4**
BET data of synthesized and commercial zeolite 13X.

| BET analyses | Syn 13X | Comm 13X |
|---|---|---|
| Pore size (nm) | 10.5059 | 7.2752 |
| Specific surface area ($m^2/g$) | 324.584 | 310.0906 |
| Pore volume ($cm^3/g$) | 0.135847 | 0.135951 |

samples was measured by nitrogen adsorption at −196.15 °C. Prior to analyses, the samples were degassed in vacuum at 105 °C for 12 h. The specific surface area was calculated using the Brunauer-Emmett-Teller (BET) method [2].

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## Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.07.040.

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