SUPPORTING INFORMATION

Urea-formaldehyde derived porous carbons for adsorption of CO_2

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1. Adsorption kinetic models

Kinetics of CO_2 uptake give useful information about the efficiency of the adsorption process. Here three kinetic models were used for to evaluate CO_2 uptake on UFZ-700.

The Lagergren pseudo–first-order model expressed as:[1]

$$q_t = q_e\left(1-\exp\left(-k_f t\right)\right) \quad (1)$$

where k_f : pseudo–first-order model constant (min $^{-1}$).

The pseudo-second order model is given as:[1]

$$q_t = \frac{k_2 q_e^2 t}{1+k_2 q_e t} \quad (2)$$

where k_2 : pseudo–second-order rate constant (g mmol $^{-1}$ min $^{-1}$).

The fractional - order rate model is given as:[2]

$$q_t = q_e - \frac{1}{[((n-1)\,k_n/m)t^m + (1/q_e^{n-1})]^{1/n-1}} \quad (3)$$

where m and n: model constants.

Coefficient of determination (R^2) and error (%) was used for to evaluate accuracy of models,

$$Error\ (\%) = \sqrt{\frac{\sum[q_{t(\exp)} - q_{t(pred)}/q_{t(\exp)}]^2}{N-1}} \times 100 \quad (4)$$

where, $q_{t(pred)}$ and $q_{t(exp)}$ are the predicted and experimental CO_2 loading, respectively.

2. Adsorption isotherm studies

To study the adsorption equilibrium three isotherms Langmuir, Freundlich and Temkin isotherm were analyzed.[3]

Langmuir adsorption isotherm assumes that binding sites are homogeneously distributed over the adsorbent surface. It can be expressed as:

$$q_e = \frac{q_m K_L P}{1 + K_L P} \quad (5)$$

where q_m : maximum adsorption capacity, mmol g^{-1}, and K_L: Langmuir constant, atm^{-1} and it indicate adsorption affinity.

Freundlich adsorption isotherm is an empirical equation used to describe heterogeneous systems. It can be given as:

$$q_e = K_F P^{1/n} \quad (6)$$

where K_F and 1/n are sorption capacity and sorption intensity, respectively. If the value of n>1, it represents favorable adsorption condition.[1]

Temkin isotherm assumes that the heat of adsorption (function of temperature) decrease linearly rather than logarithmic with coverage. The equation can be expressed as follows:

$$q_e = B \ln(K_T P) \quad (7)$$

where $K_T\ (atm^{-1})$ and $B = RT/b$ with b (J mol^{-1}) are the Temkin constants. R (8.314 J mol^{-1} K^{-1}) and T (K) is the temperature.

3. Adsorption thermodynamics

The standard Gibbs free energy ΔG^0 (J mol^{-1}), standard molar adsorption enthalpy ΔH^0 (J mol^{-1}), and standard entropy change can be obtained using following equations:

$$\Delta G^\circ = -RT \ln(K_{eq}) \quad (8)$$

$$\ln(K_{eq}) = -\frac{\Delta H^\circ}{R}\frac{1}{T} + \frac{\Delta S^\circ}{R} \quad (9)$$

where K_{eq} : equilibrium constant for adsorption.

ΔH^0 and ΔS^0 can be calculated from the slope and intercept of van't Hoff plot, respectively. [4]

Enthalpy of adsorption can be obtained from isosteric heat of adsorption Q_{st} which represents strength of adsobate-adsorbent interaction. The $Q_{st}\ (kJ\ mol^{-1})$ can be expressed by Clausius-clapeyron equation:

$$Q_{st} = -R\left[\frac{\partial \ln P}{\partial\left(\frac{1}{T}\right)}\right]_{q_e} \quad (10)$$

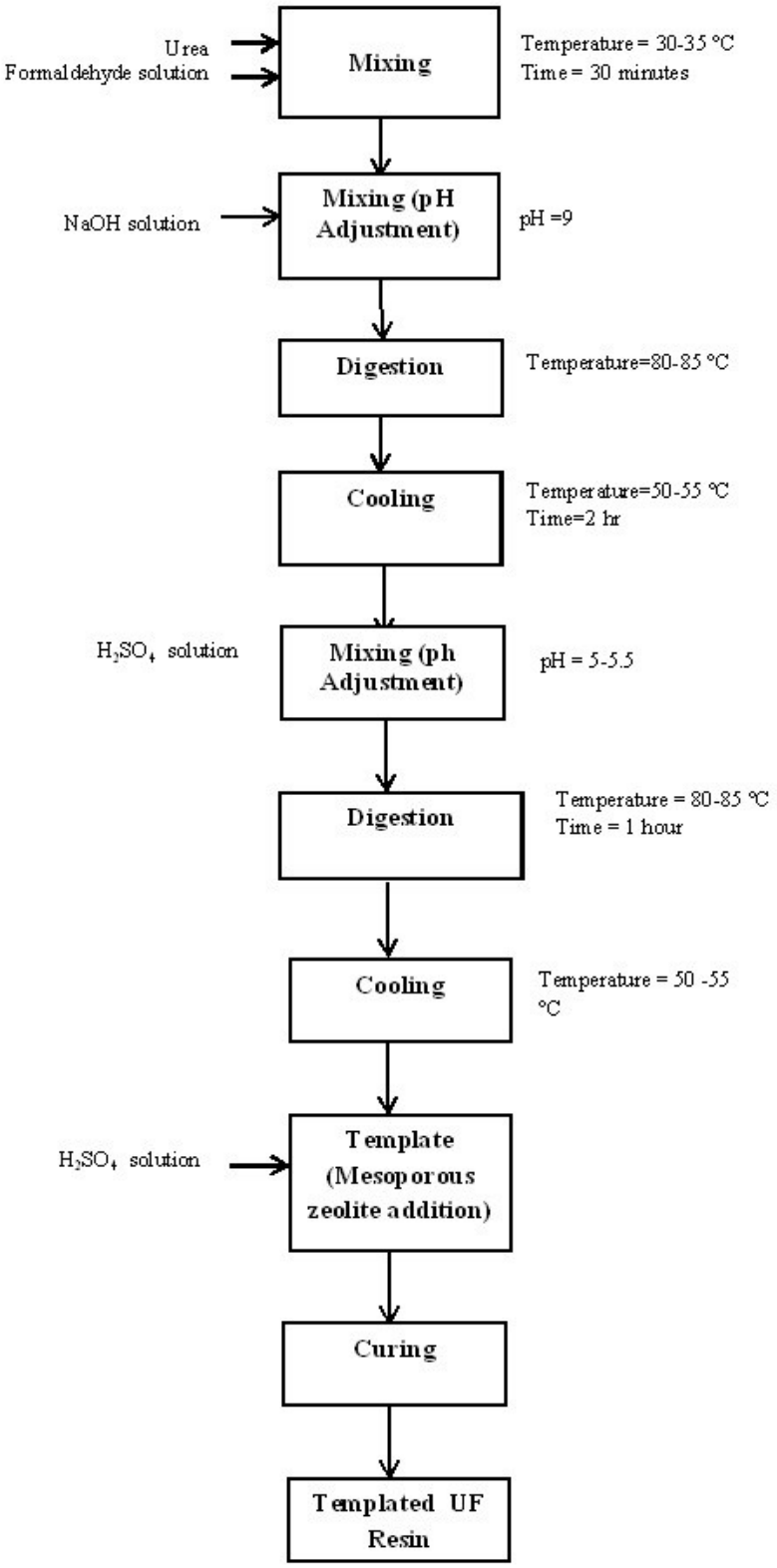

Fig. S1 Block diagram of preparation method of carbon adsorbents

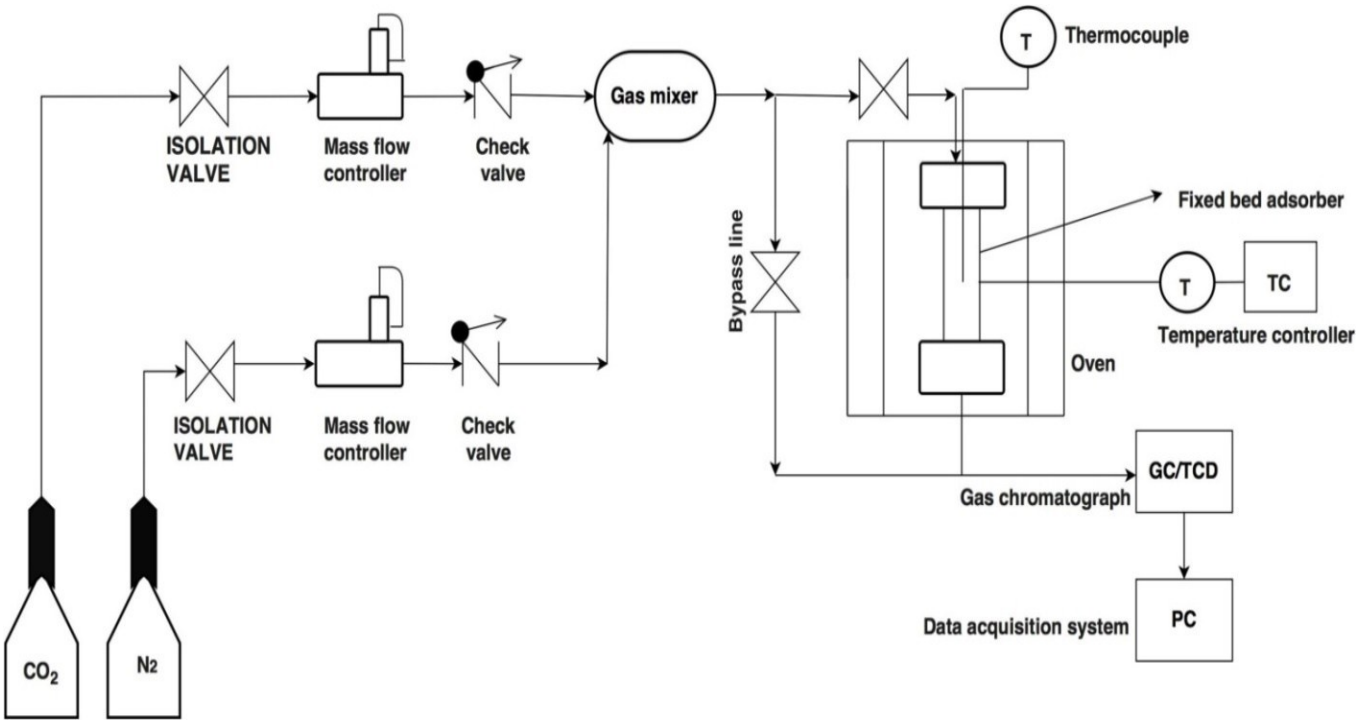

Fig. S2 Schematic experimental setup used for adsorption–desorption experimental setup[5]

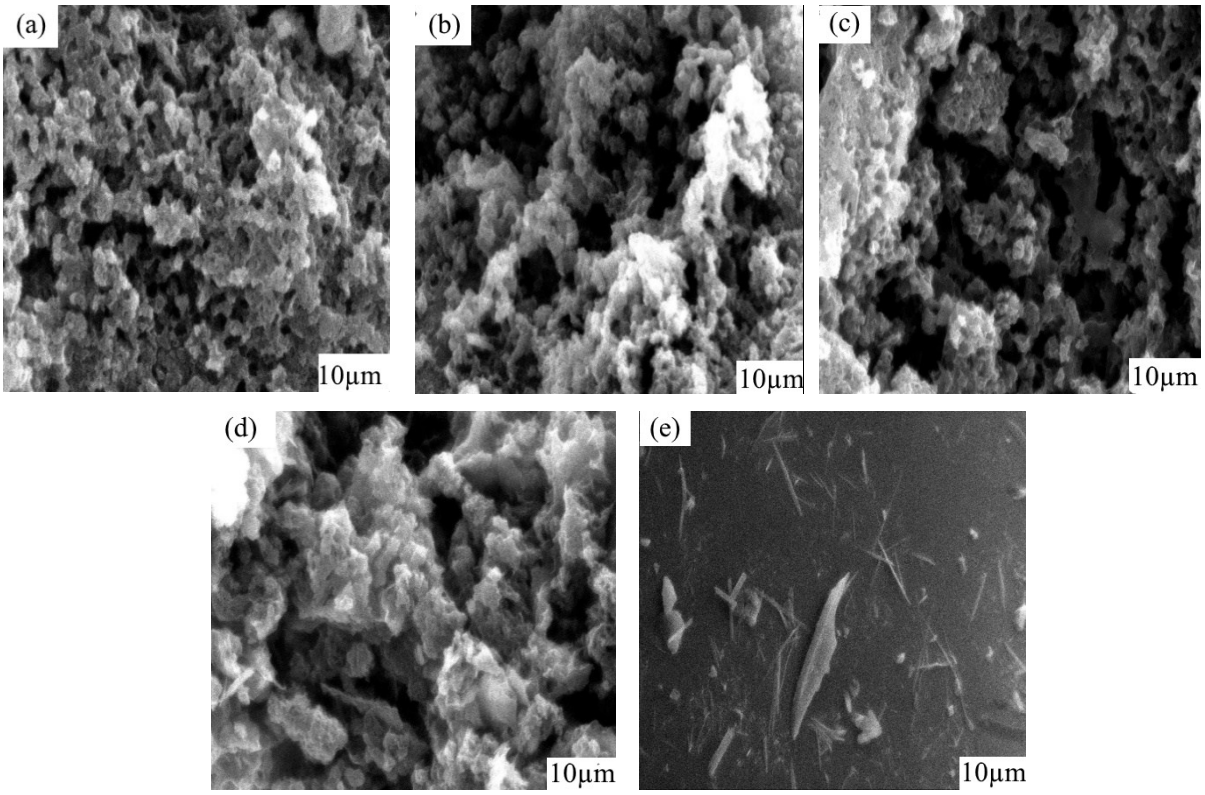

Fig. S3 SEM images of (a) UFZ-500, (b) UFZ-600, (c) UFZ-700, (d) UFZ-800 and (e) UF-700

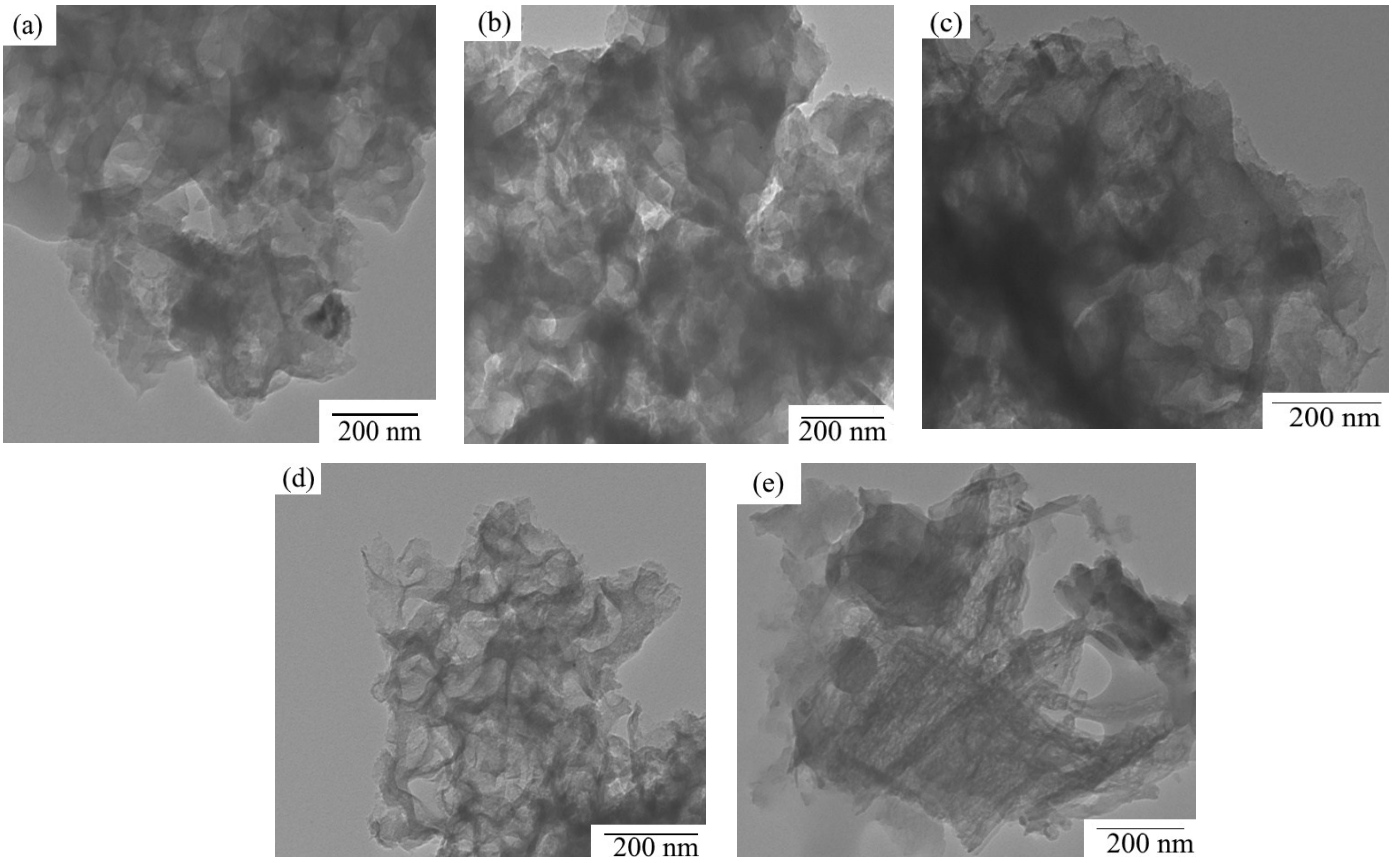

Fig. S4 TEM images of (a) UFZ-500, (b) UFZ-600, (c) UFZ-700, (d) UFZ-800 and (e) UF-700

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