



Supplementary Materials

Table S1. Composition of DES

No.	Type of DES	Component	Ratio	Abbreviation
1	Binary	Choline chloride mixed with ethylene glycol	1:1	DES 1
2	Binary	Choline chloride mixed with ethylene glycol	1:2	DES 2
3	Ternary	Choline chloride mixed with urea and ethylene glycol	1:1:1	DES 3
4	Ternary	Choline chloride mixed with urea and ethylene glycol	1:2:2	DES 4

Table S2. Physical state of DES

Sample	Component	Ratio	Phase
DES 1	Choline chloride mixed with ethylene glycol	1:1	Liquid with crystals
DES 2	Choline chloride mixed with ethylene glycol	1:2	Liquid
DES 3	Choline chloride mixed with urea and ethylene glycol	1:1:1	Liquid with crystals
DES 4	Choline chloride mixed with urea and ethylene glycol	1:2:2	Liquid

Table S3. Viscosity of DES at various temperatures

Sample	Viscosity (mPa.s)			Reference
	30°C	40°C	50°C	
DES 2	28.4	20.0	14.7	This work
DES 4	34.7	22.8	15.8	This work
Choline chloride mixed with urea (1:2 ratio)	527.1	237.9	119.7	[1]

Table S4. Elemental composition of adsorbents

Adsorbent	Element (wt.%)		
	Carbon	Oxygen	Nitrogen
Raw AC	88.42	11.58	-
ACPC	83.20	16.80	-
ACPA	85.08	14.92	-
AC-DES 2	82.23	13.66	4.11
AC-DES 4	77.43	14.68	7.89

Table S5. Textural parameters of adsorbents

Adsorbent	BET surface area (m ² /g)	t-plot micropore volume (cm ³ /g)
Raw AC	1055.05	0.33
ACPC	826.69	0.25
ACPA	1073.19	0.34
AC-DES 2	969.04	0.32
AC-DES 4	922.20	0.30

Table S6. CO₂ adsorption capacity, breakthrough time and saturation time of various adsorbents at different temperature.

	T (°C)	Raw AC	ACPC	ACPA	AC-DES 2	AC-DES 4
CO₂ adsorption capacity (mg /g)	25	10.8	90.6	116.5	32.4	66.9
	35	6.3	58.5	89.8	20.9	48
	45	4.0	40.4	74.8	16.2	40.4
	55	2.0	33.3	60.8	11.8	31.4
Breakthrough time (min)	25	5	42	54	15	31
	35	3	28	43	10	23
	45	2	20	37	8	20
	55	1	17	31	6	16
Saturation time (min)	25	14	54	65	25	41
	35	12	41	56	20	32
	45	11	30	47	18	30
	55	10	27	43	15	27

*(Operating conditions: temperature at 25-55°C, inlet CO₂ concentration at 15%, and inlet flow rate at 200 mL/min)

Table S7. CO₂ adsorption capacity, breakthrough time and saturation time of various adsorbents at different CO₂ concentration

	CO ₂ (%)	Raw AC	ACPC	ACPA	AC-DES 2	AC-DES 4
CO₂ adsorption capacity (mg/g)	15	10.8	90.6	116.5	32.4	66.9
	18	11.7	101.0	126.9	33.7	75.0
	20	11.8	106.5	132.4	34.5	80.6
Breakthrough time (min)	15	5	42	54	15	31
	18	4.5	39	49	13	29
	20	4.1	37	46	12	28
Saturation time (min)	15	14	54	65	25	41
	18	13	48	59	23	39
	20	12	46	56	20	37

*(Operating conditions: temperature at 25°C, inlet CO₂ concentration at 15-20%, and inlet flow rate at 200 mL/min)

Table S8. CO₂ adsorption capacity, breakthrough time and saturation time at different activating agents.

Adsorbent	CO ₂ adsorption capacity (mg /g)	Breakthrough time (min)	Saturation time (min)
Raw AC	10.8	5	14
ACPC	90.6	42	54
ACPA	116.5	54	65
AC-DES 2	32.4	15	25
AC-DES 4	66.9	31	41

*(Operating conditions: temperature at 25°C, inlet CO₂ concentration at 15%, and inlet flow rate at 200 mL/min)

Reference

1. Shekaari H, Zafarani-Moattar MT, Mohammadi B. Thermophysical characterization of aqueous deep eutectic solvent (choline chloride/urea) solutions in full ranges of concentration at T =(293.15–323.15) K. *J. Mol. Liq.* 2017;243:451–461. <https://doi.org/https://doi.org/10.1016/j.molliq.2017.08.051>.