An efficient system for direct air capture utilizes diamine as sorbent.

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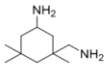
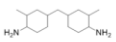
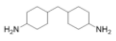
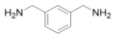
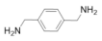
The liquid–solid phase separation phenomenon exhibited a high removal efficiency for low concentration CO_2, which has potential for direct air capture (DAC).[1] In this work, a series of aqueous diamine solutions was screened for capturing 400 ppm CO_2. All amine loaded more than1 equilibrium CO_2, and white solid precipitates appeared in this system at the begging stage of CO_2 absorption (**Table 1**). In particular, isophorone diamine (IPDA) maintained >90% CO_2 removal from 400 ppm CO_2 for 726 min (T_{90} value), and the durability was highest among tested amines, and IPDA showed >99% CO_2 removal even under a 500 mL min^{-1}, in which the contact rate between CO_2 and IPDA aqueous solution and the CO_2 absorption rate reached 13,760 h^{-1} and 540 μmol h^{-1} mol_{IPDA}^{-1}, respectively (Figure 1). The CO_2 was captured in aqueous IPDA solution that 90% of the captured CO_2 could be recycled. The precipitate from IPDA was analyzed by ^{13}C NMR (164.85 and 161.23 ppm) and FT-IR (absorption bands at 1600-1660 cm^{-1}), revealing the structure of products as (isophorondiamine)carbamic acid and bicarbonate (HCO_3^-/CO_3^{2-}). Therefore, this work provides a foundation for establishing a solid–liquid phase change system for a highly efficient and environmentally friendly DAC system using aqueous solvent.

Table1. CO_2 adsorption properties of various diamines in aqueous solution for 400 ppm CO_2-N_2.

Entry	Amine	T_{90}/min	CO_2/mmol
1		726	1.03
2		65	1.09
3		27	1.26
4		2	1.07
5		441	1.28

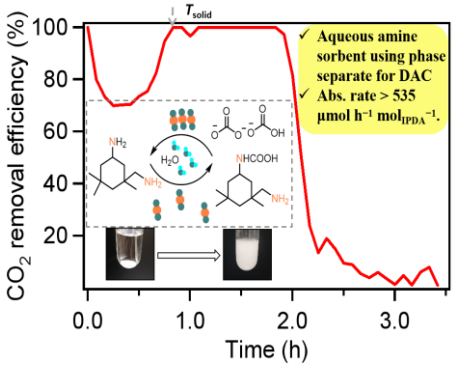


Figure 1. CO_2 removal efficiency over IPDA under 500 mL/min gas flow rates of 400 ppm CO_2. IPDA: 1 mmol; H_2O: 2 mL; (S_{abs} = 1.06).

1) (a) P. Luis *et. al.*, *Desalination* **2016**, *380*, 93−99. (b) X. Jin *et. al.*, *Sep. Purif. Technol.* **2022**, *298*, 120630. (c) S. Kikkawa *et. al.*, *ACS Environ. Au* **2022**, *2*, 354−362. (d) F. Inagaki *et. al.*, *J. Am. Chem. Soc.* **2017**, *139*, 4639−4642.