Electronic Supplementary Information

Efficient absorption of ammonia with dialkylphosphate-based ionic liquids

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Table S1 The water contents of the ILs

IL	$[C_4C_1im]$ [DBP]	$[C_4C_1im]$ [DMP]	$[C_2C_1im]$ [DEP]	$[C_2C_1im]$ [DMP]	$[C_1C_1im]$ [DMP]
H_2O /ppm	276	232	353	259	388

Table S2 The density ρ and viscosity η of dialkylphosphate-based ILs at 298.15 K and 0.1 MPa

Component	ρ/(g·cm^{-3})		η/(mPa·s)	
	Exp.	Lit.	Exp.	Lit.
[bmim][DMP]	1.1645	1.1619[a]	543.01	584.74 [a]
[emim][DMP]	1.2242	1.22[a]	249.67	269.872[a]
[emim][DEP]	1.1466	1.146[b]	419.29	410[c]
[mmim][DMP]	1.2616	1.2587[d]	290.32	271.86[d]
[bmim][DBP]	1.0454	*NA*	1741.1	*NA*

Reference

[a] Y H. Gong, C. Shen, Y.Z. Lu, H. Meng, C.X. Li, J. Chem. Eng. Data., 57 (2012) 33-39.
[b] W.M.D.W. Normazlan, N. A.Sairi, Y. Alias, A.F. Udaiyappan, A. Jouyban, M. Khoubnasabjafari, J. Chem. Eng. Data., 59 (2014) 2337-2348.
[c] C. M. Tenney, M. Massel, J. M. Mayes, M. Sen, J. F. Brennecke, E. J. A. Marginn, J. Chem. Eng. Data., 59 (2014) 391-399.
[d] Z.B. He, Z.C. Zhao, X.D. Zhang, H. Feng, Fluid Phase Equilibr., 298 (2010) 83-91.

Table S3 The comparison of density and volume before and after CO_2 absorption at 303.15 K

IL	ρ(IL) /g·cm^{-3}	V(IL) /cm³	ρ(IL+CO_2) /g·cm^{-3}	V(IL+CO_2) /cm³	ΔV/%
[C_4C_1im][DBP]	1.0392	11.503	1.0445	11.746	2.11
[C_4C_1im][DMP]	1.1537	11.260	1.1542	11.559	2.65
[C_2C_1im][DEP]	1.1403	10.104	1.1426	10.337	2.31
[C_2C_1im][DMP]	1.2141	9.971	1.2079	10.350	3.79
[C_1C_1im][DMP]	1.2562	9.483	1.2527	9.783	3.15

Table S4 Uncertainties of the used instruments in measurements

Measurements	Uncertainties
Density/ (g· cm^{-3})	0.002
Viscosity/mPa· s	0.05
Solubility	0.005
Temperatures of water bath/K	0.05
Pressure transmitter /kPa	0.1
Mass of ILs /g	0.001

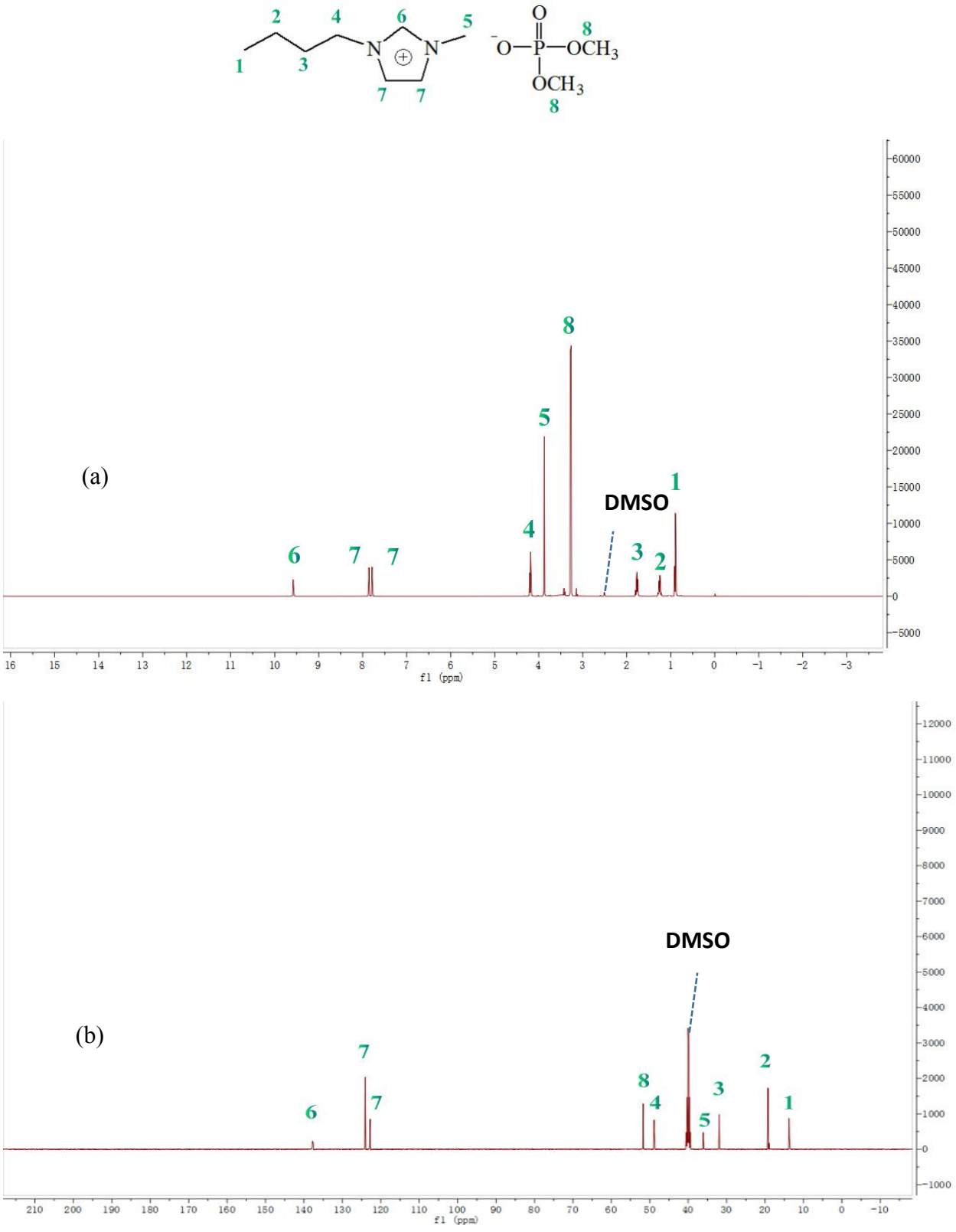


Figure S1 NMR spectra for [C_4C_1im][DMP] (1-butyl-3-methylimidazolium dimethylphosphate) in DMSO-d6 with tetramethylsilane (TMS) as the internal standard: (a) ^{1}H NMR and (b) ^{13}C NMR.

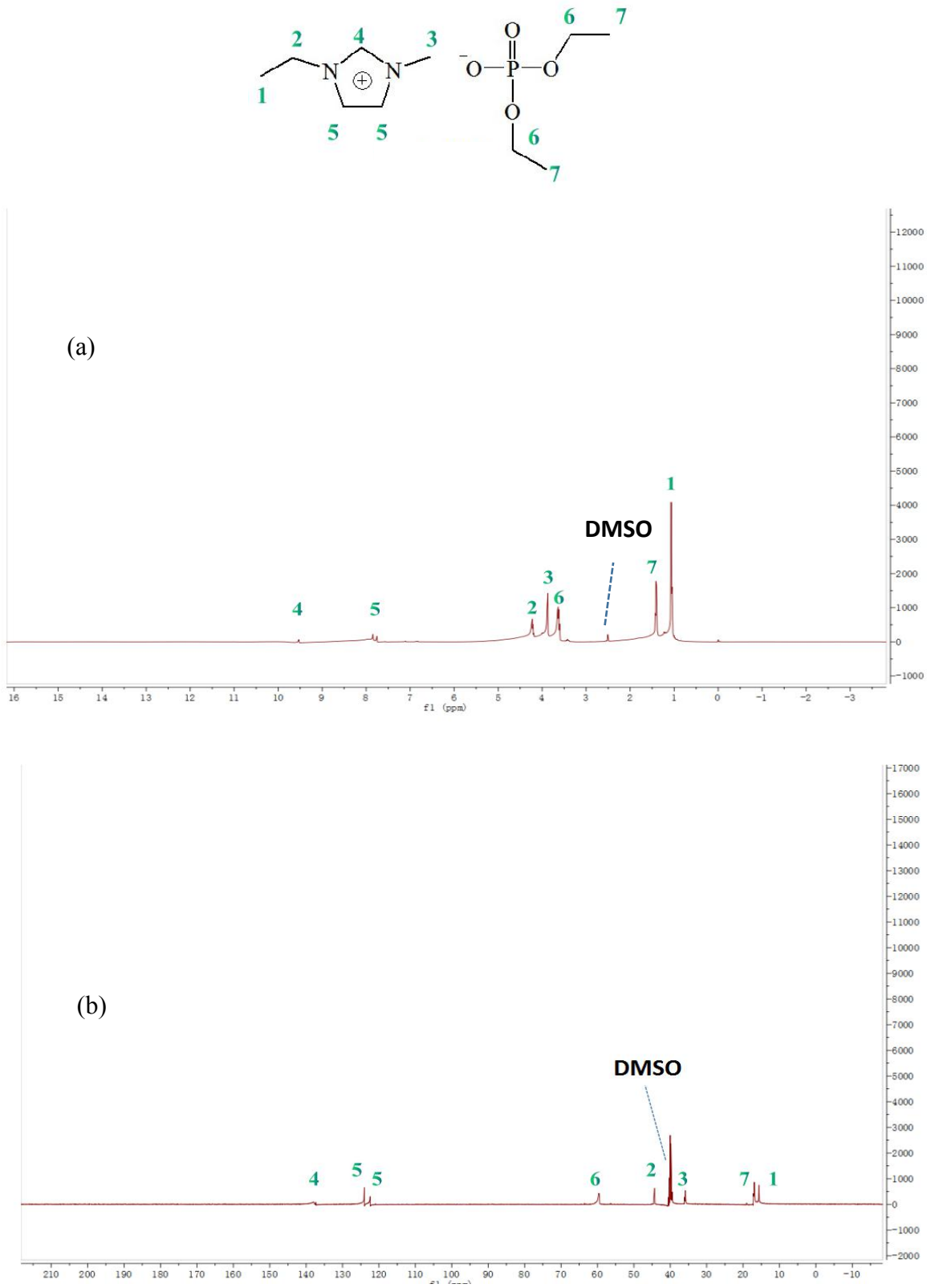


Figure S2 NMR spectra for [C_2C_1im][DEP] (1-ethyl-3-methylimidazolium diethylphosphate) in DMSO-d6 with tetramethylsilane (TMS) as the internal standard: (a) ^{1}H NMR and (b) ^{13}C NMR.

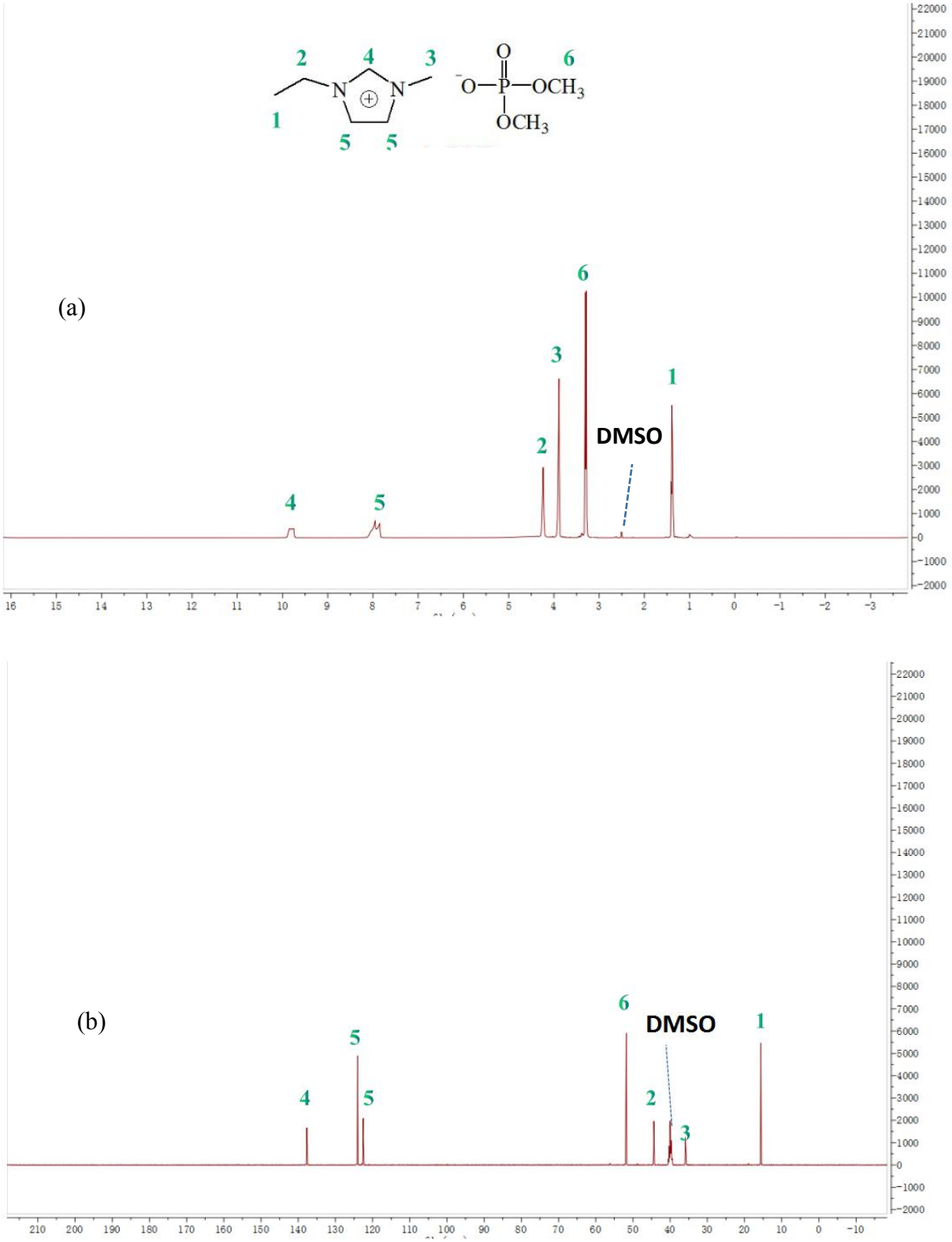


Figure S3 NMR spectra for [C_2C_1im][DMP] (1-ethyl-3-methylimidazolium dimethylphosphate) in DMSO-d6 with tetramethylsilane (TMS) as the internal standard: (a) ^{1}H NMR and (b) ^{13}C NMR.

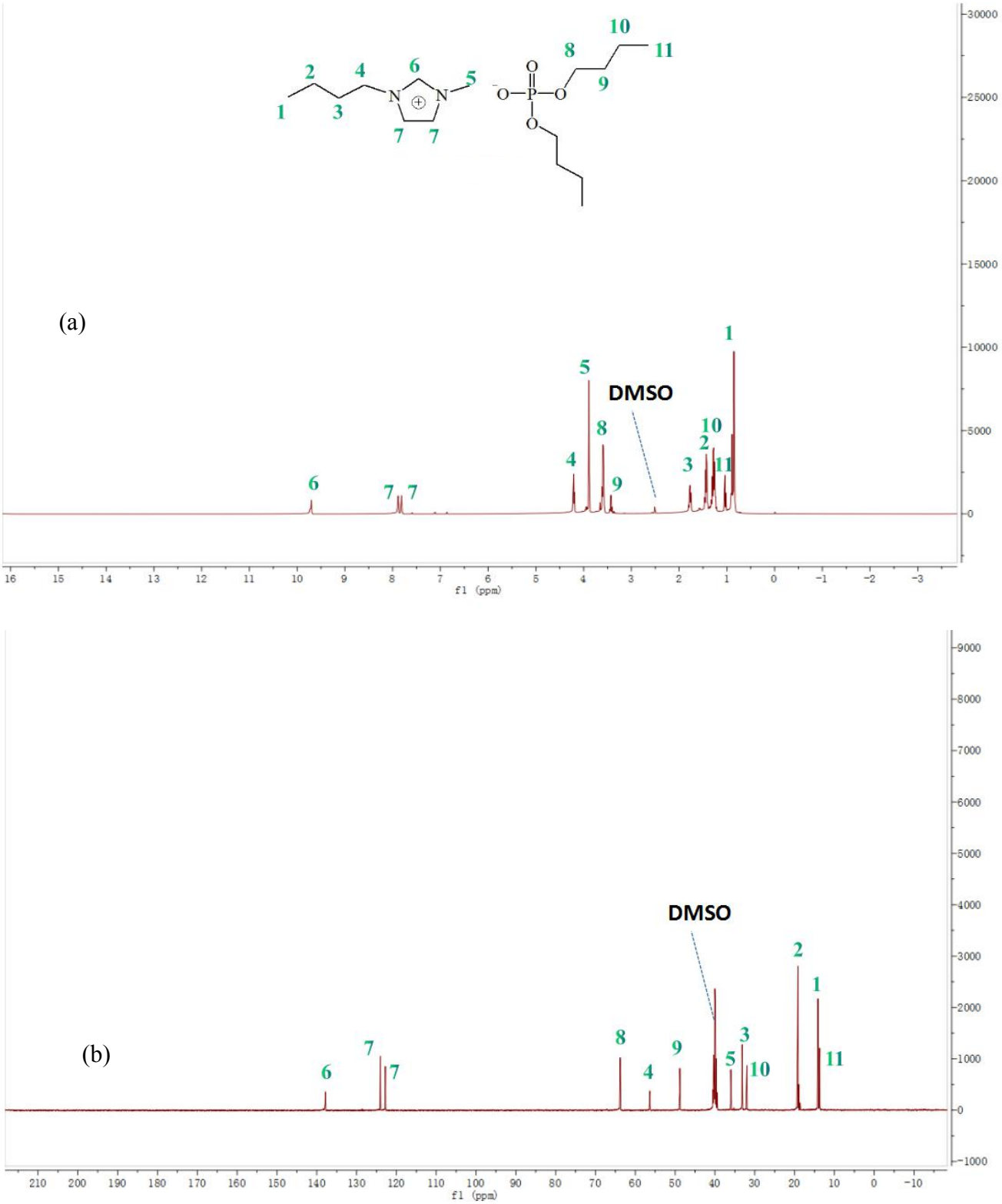


Figure S4 NMR spectra for [C_4C_1im][DBP] (1-butyl-3-methylimidazolium dibutylphosphate) in DMSO-d6 with tetramethylsilane (TMS) as the internal standard: (a) ^{1}H NMR and (b) ^{13}C NMR.

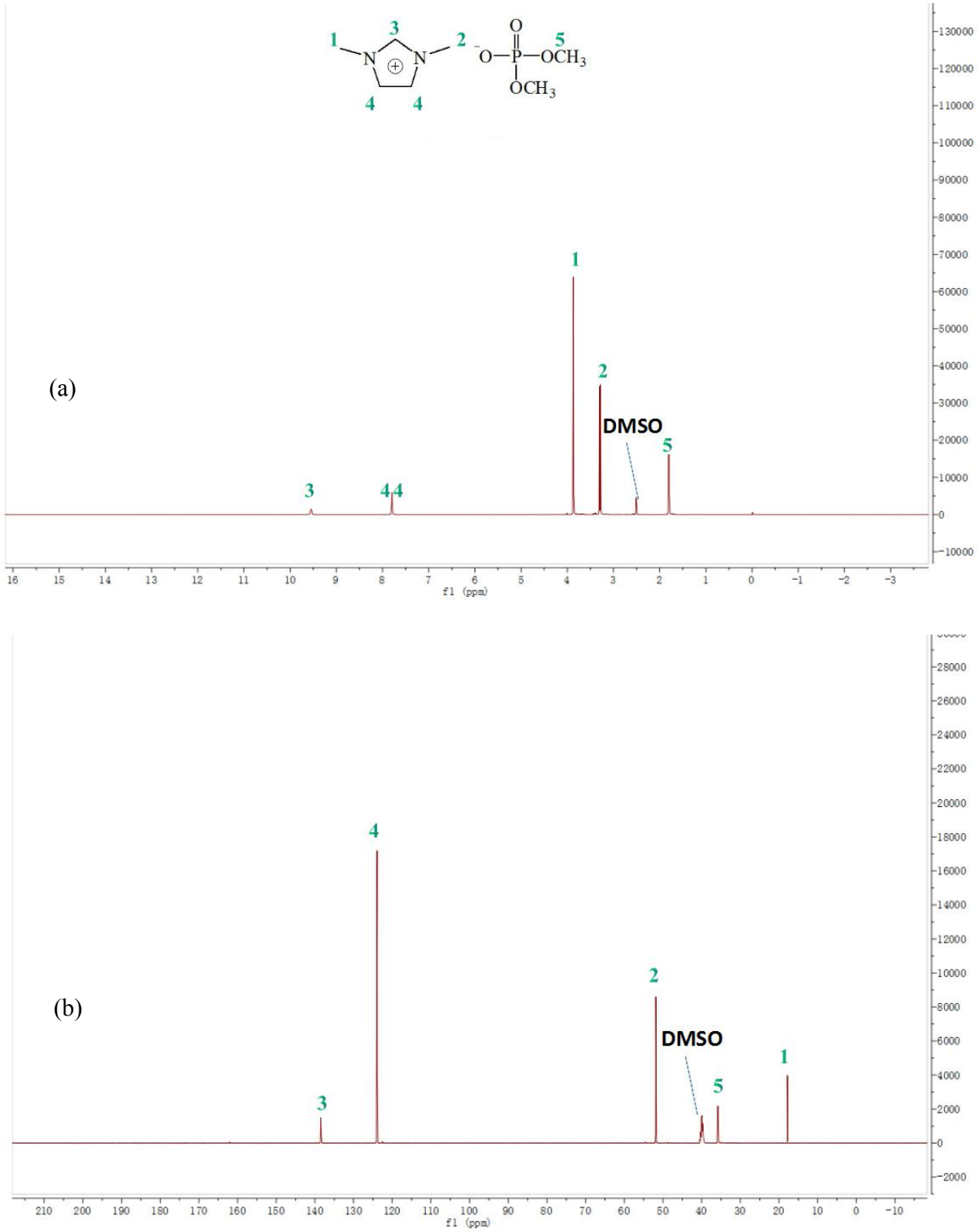


Figure S5 NMR spectra for $[C_1C_1im][DMP]$ (1,3-dimethylimidazolium dimethylphosphate) in DMSO-d6 with tetramethylsilane (TMS) as the internal standard: (a) ^{1}H NMR and (b) ^{13}C NMR.

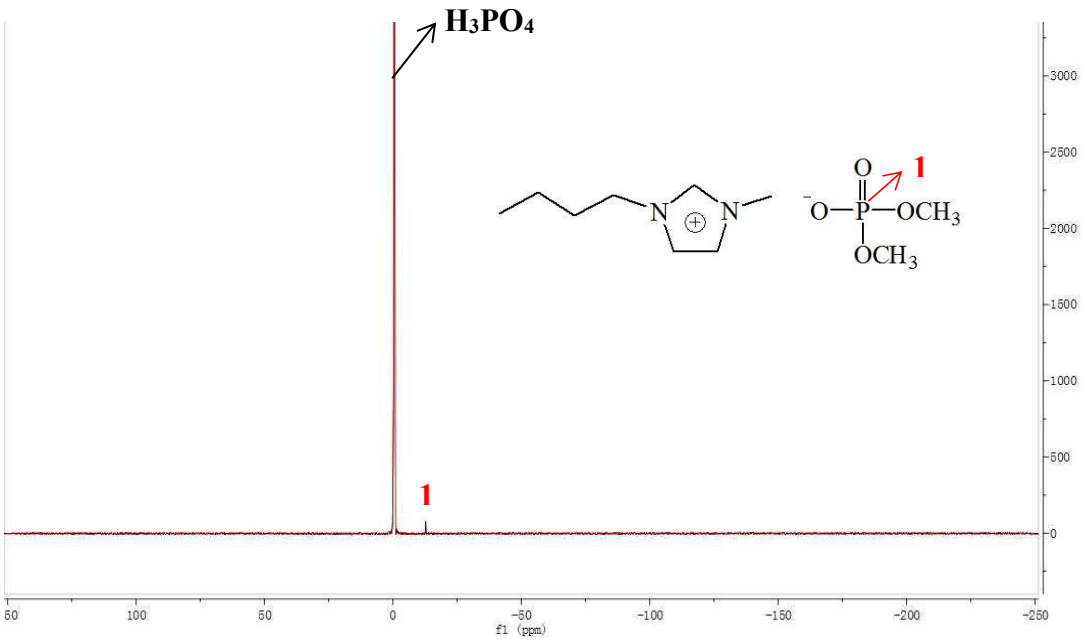


Figure S6 ^{31}P NMR spectra for [C_4C_1im][DMP] (1-butyl-3-methylimidazolium dimethylphosphate) in phosphoric acid as the internal standard.

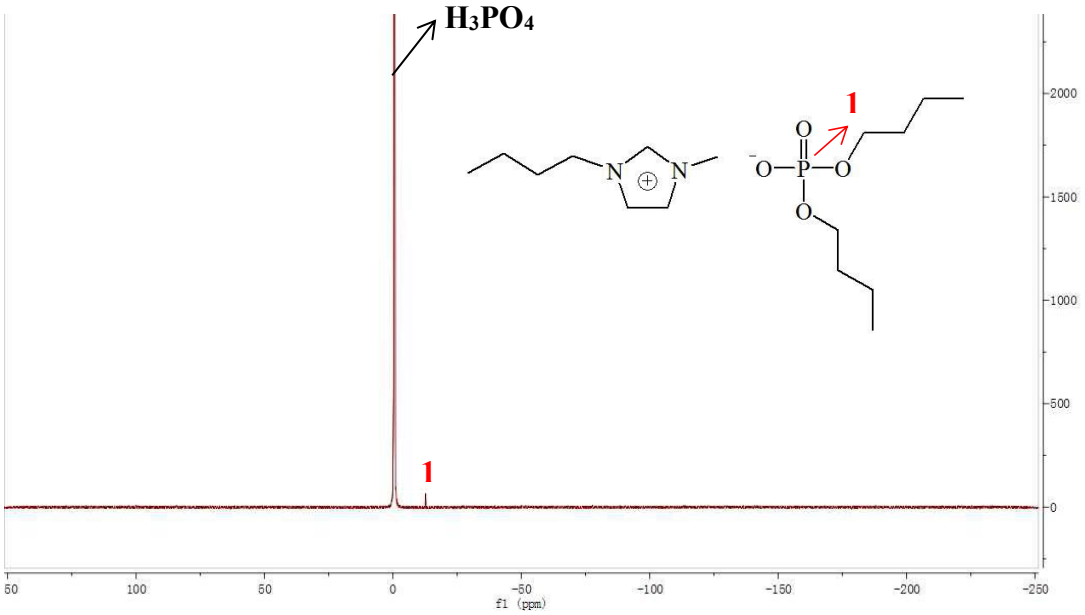


Figure S7 ^{31}P NMR spectra for [C_4C_1im][DBP] (1-butyl-3-methylimidazolium dibutylphosphate) in phosphoric acid as the internal standard.

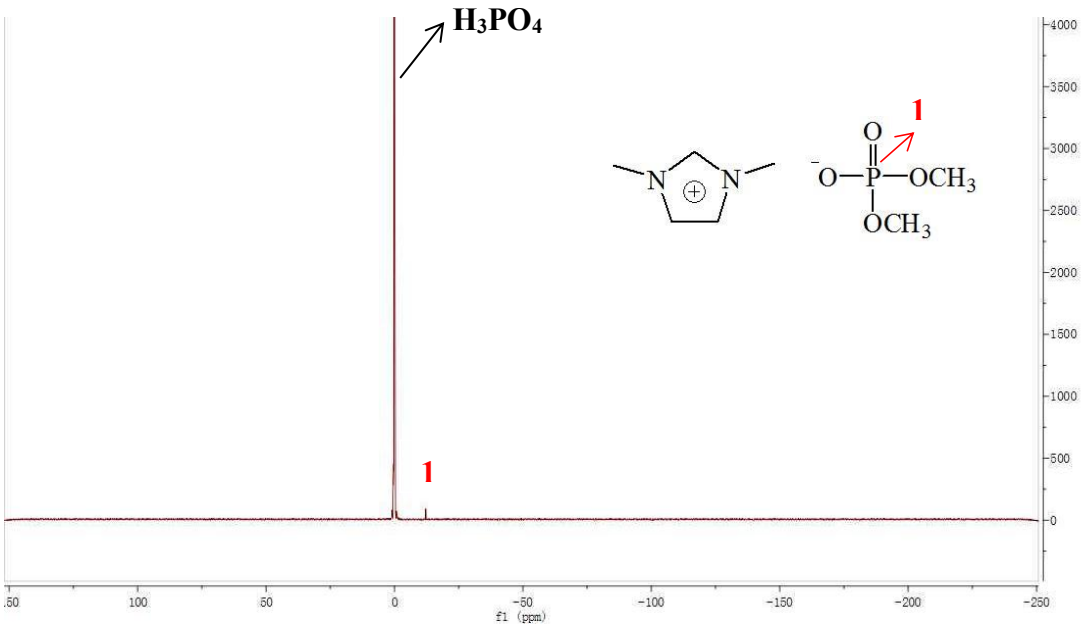


Figure S8 ^{31}P NMR spectra for [[C_1C_1im][DMP] (1,3-dimethylimidazolium dimethylphosphate) in phosphoric acid as the internal standard.

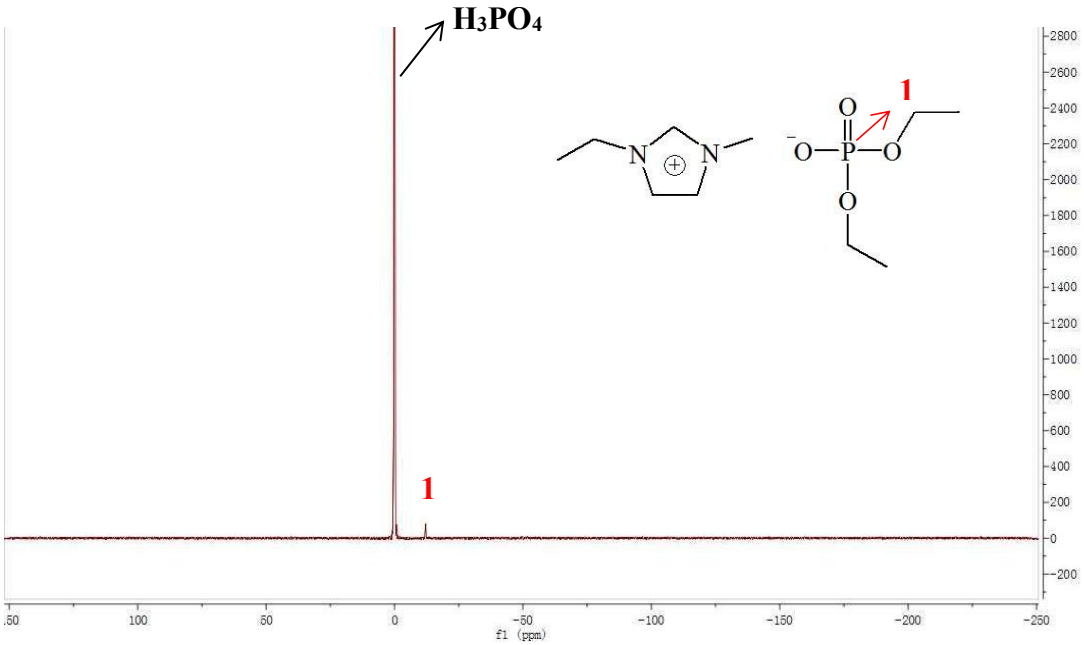


Figure S9 ^{31}P NMR spectra for [C_2C_1im][DEP] (1-ethyl-3-methylimidazolium diethylphosphate) in phosphoric acid as the internal standard.

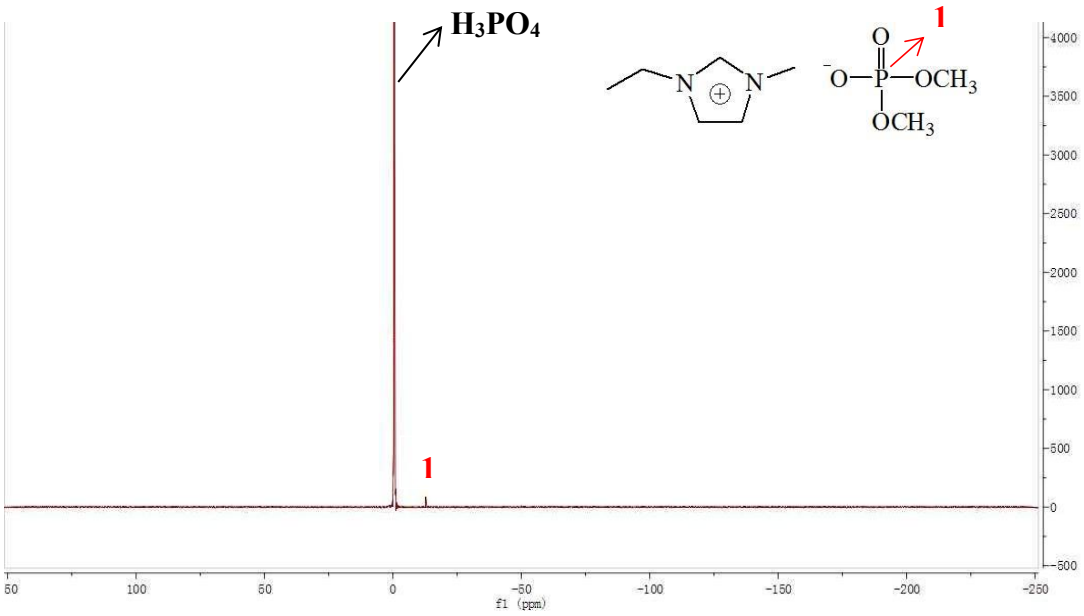


Figure S10 ^{31}P NMR spectra for [C_2C_1im][DMP] (1-ethyl-3-methylimidazolium dimethylphosphate) in phosphoric acid as the internal standard.

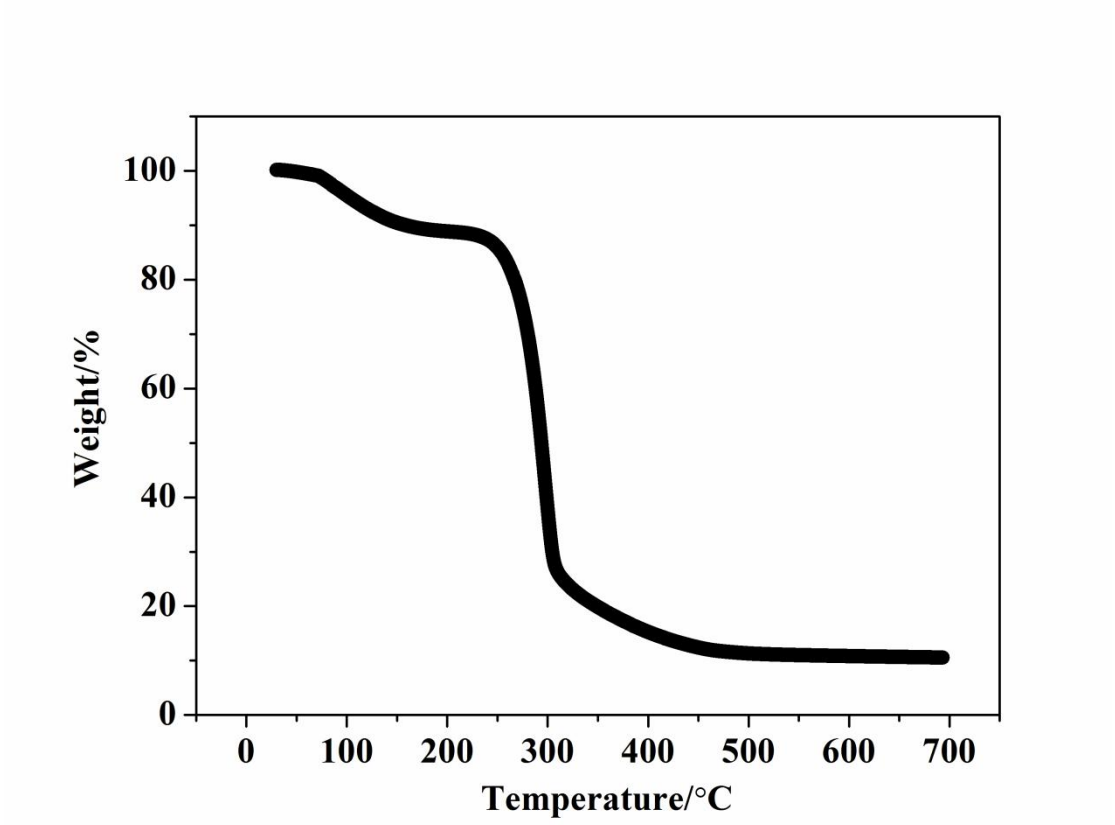


Figure S11. Scanning TGA results for [C_4C_1im][DBP] from room temperature with a 10 °C/min temperature ramping rate to 700 °C.

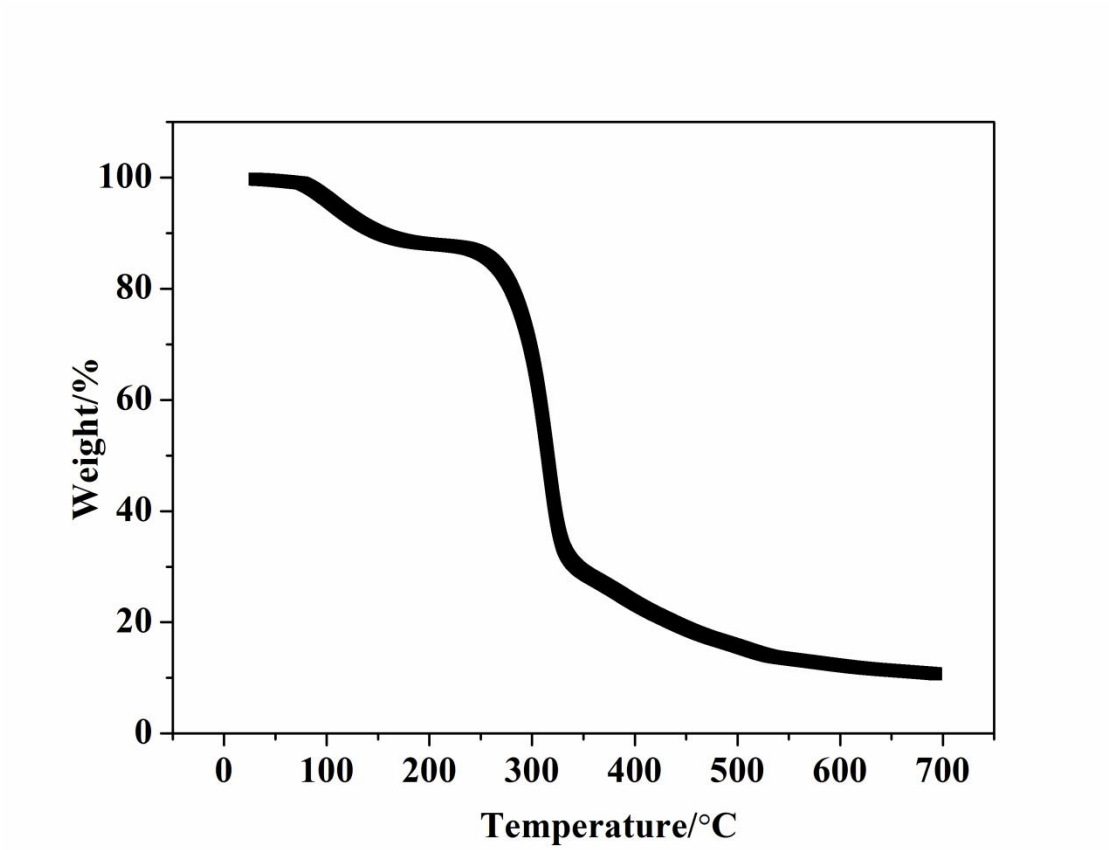


Figure S12. Scanning TGA results for [C_4C_1im][DMP] from room temperature with a 10 °C/min temperature ramping rate to 700 °C.

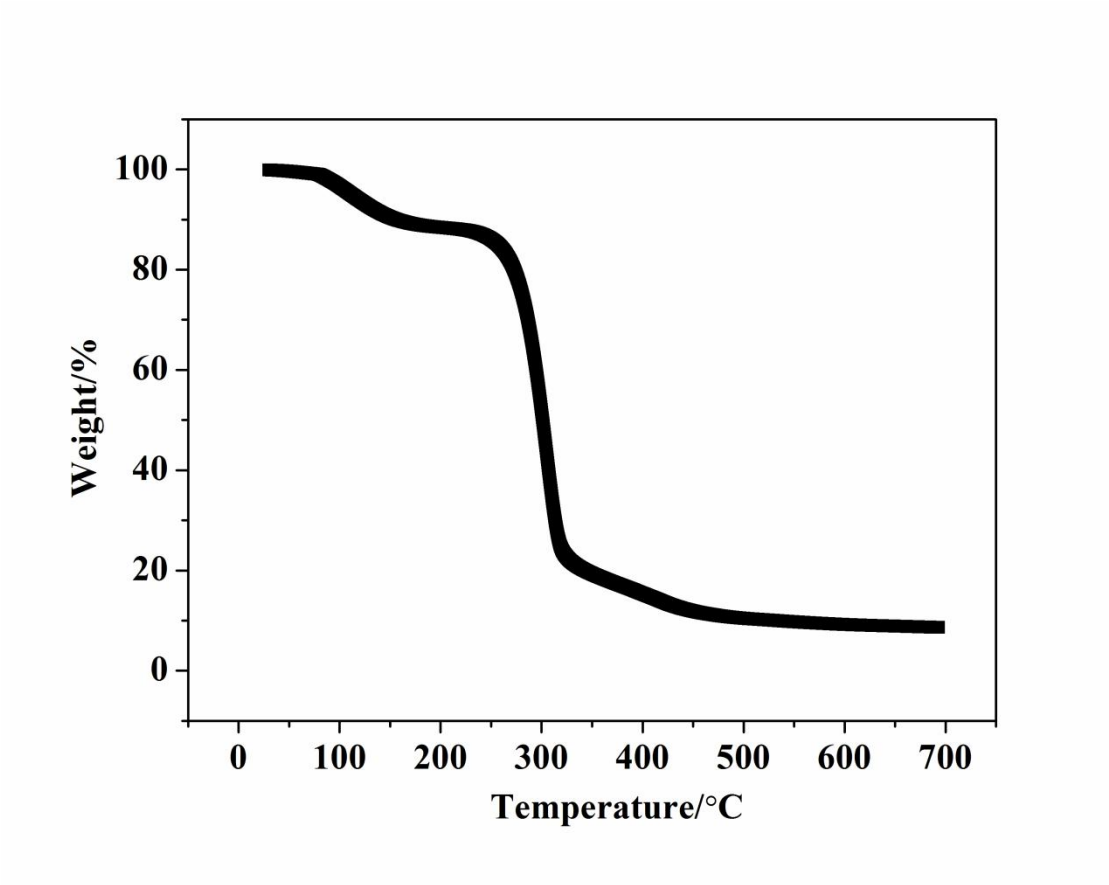


Figure S13. Scanning TGA results for [C_2C_1im][DEP] from room temperature with a 10 °C/min temperature ramping rate to 700 °C.

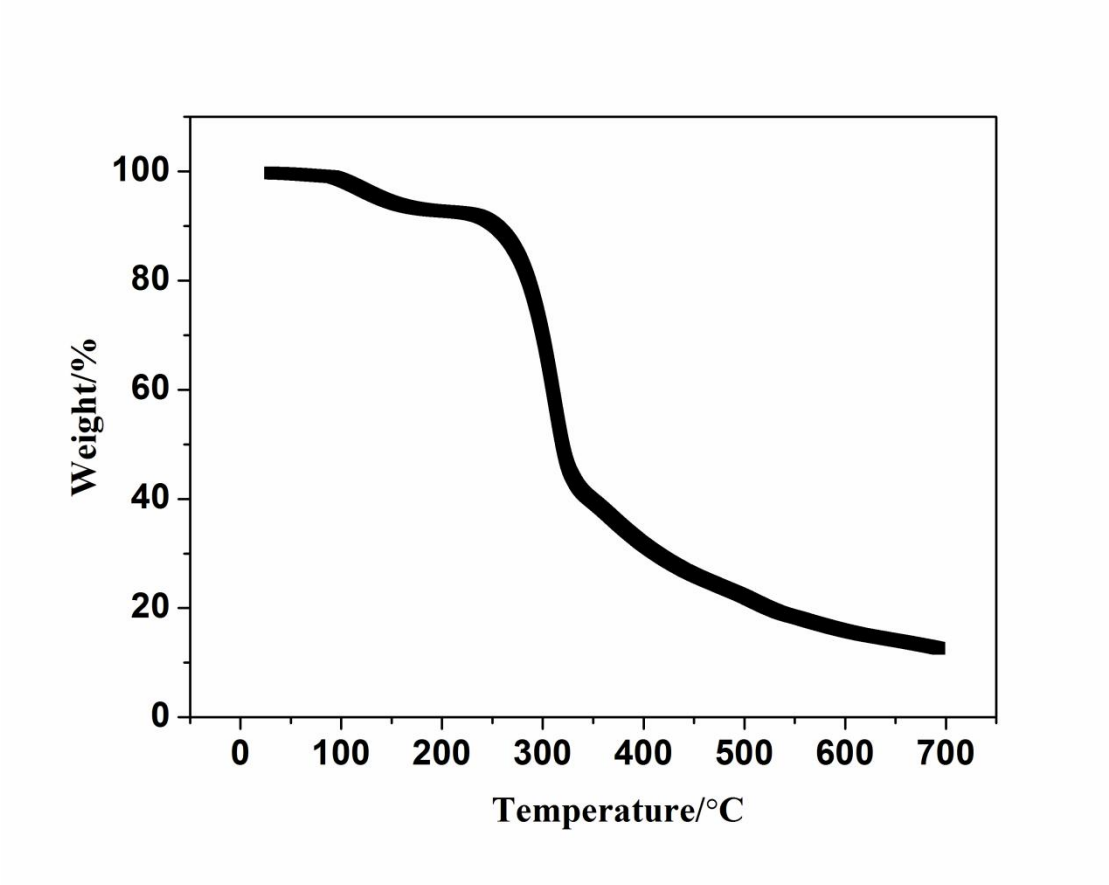


Figure S14. Scanning TGA results for [C_2C_1im][DMP] from room temperature with a 10 °C/min temperature ramping rate to 700 °C.

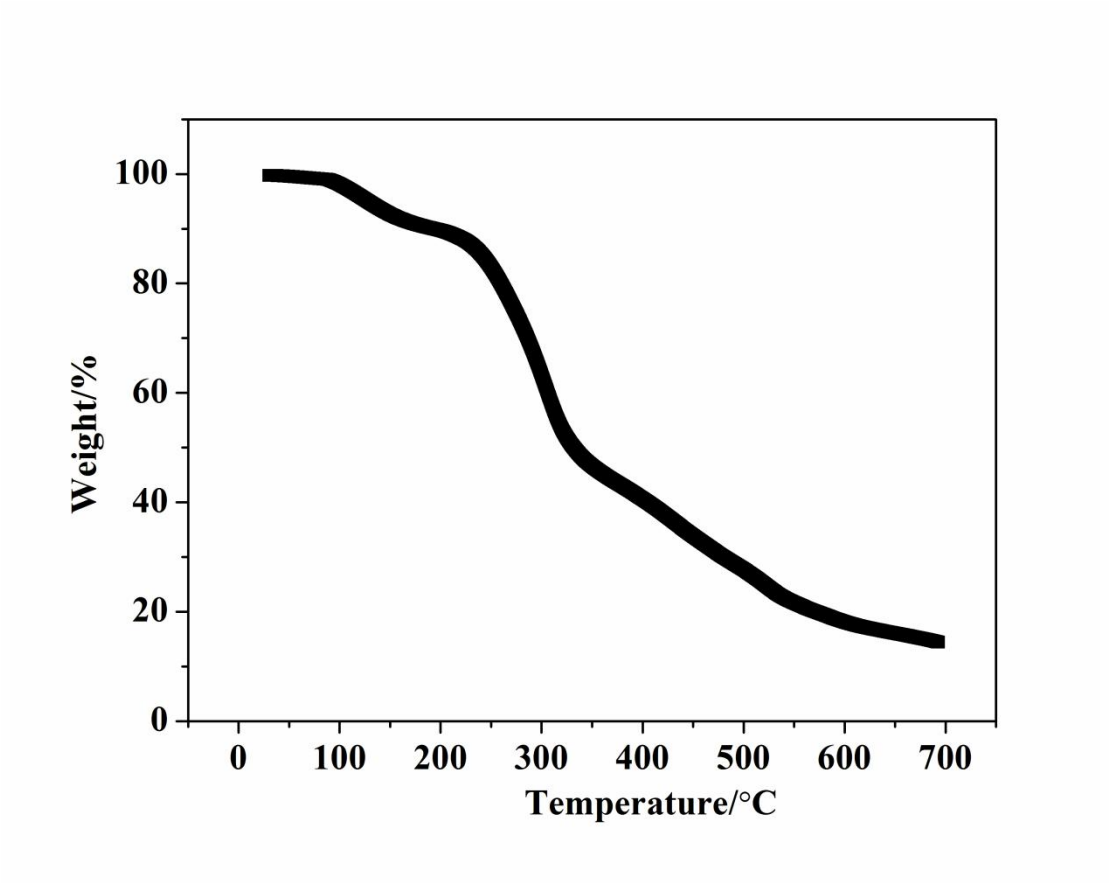


Figure S15. Scanning TGA results for [C_1C_1im][DMP] from room temperature with a 10 °C/min temperature ramping rate to 700 °C.

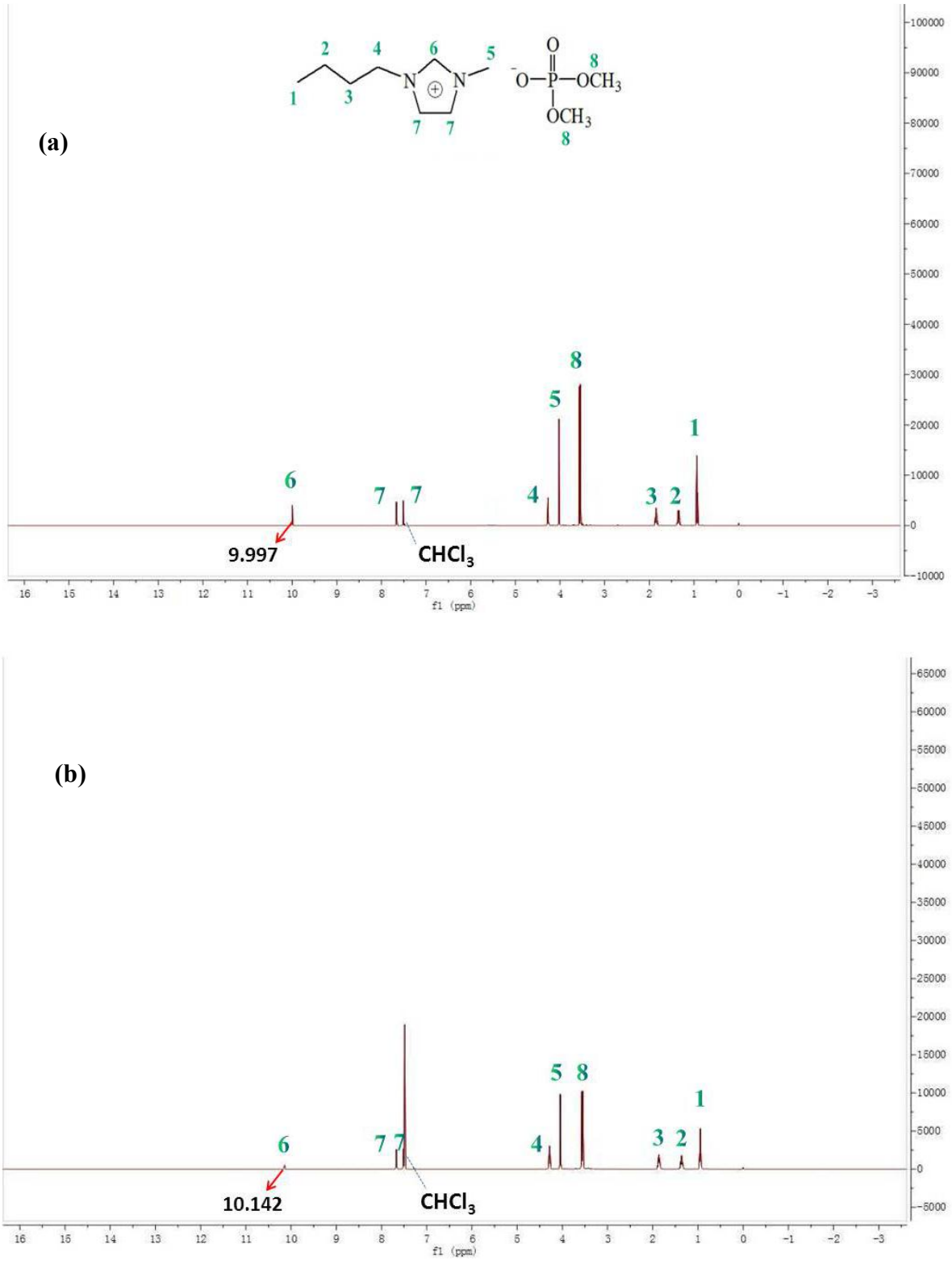
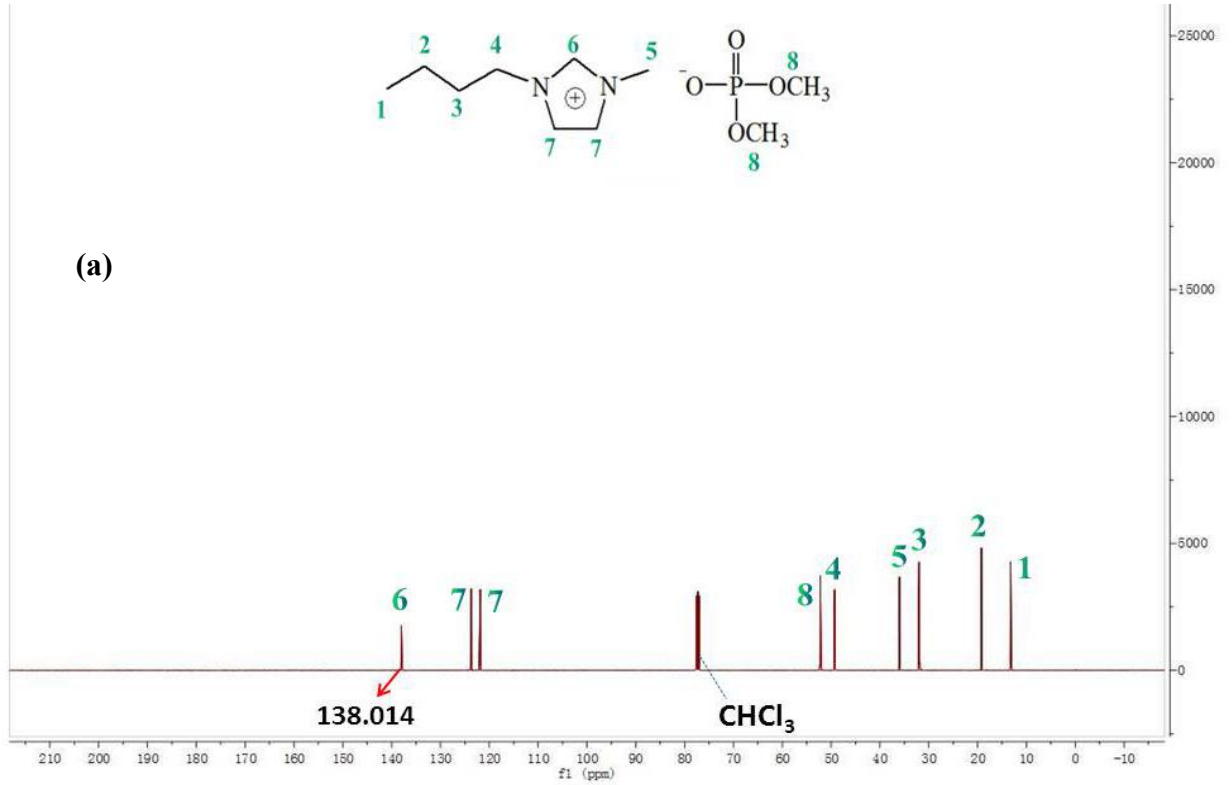


Figure S16 ^{1}H NMR spectra for $[C_4C_1im][DMP]$ (1-butyl-3-methylimidazolium dimethylphosphate) in $CDCl_3$ with tetramethylsilane (TMS) as the internal standard: (a) fresh ionic liquid; (b) ionic liquid+NH_3.



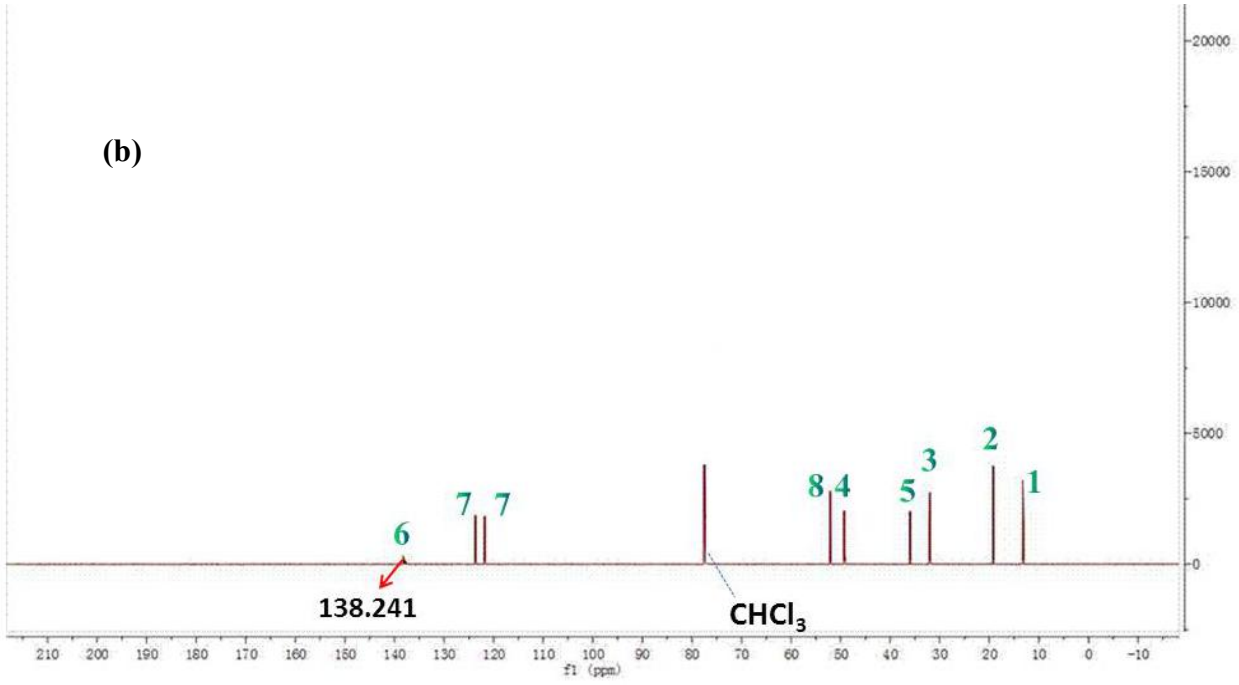


Figure S17 ^{13}C NMR spectra for $[C_4C_1im][DMP]$ (1-butyl-3-methylimidazolium dimethylphosphate) in $CDCl_3$ with tetramethylsilane (TMS) as the internal standard: (a) fresh ionic liquid; (b) ionic liquid+NH_3.

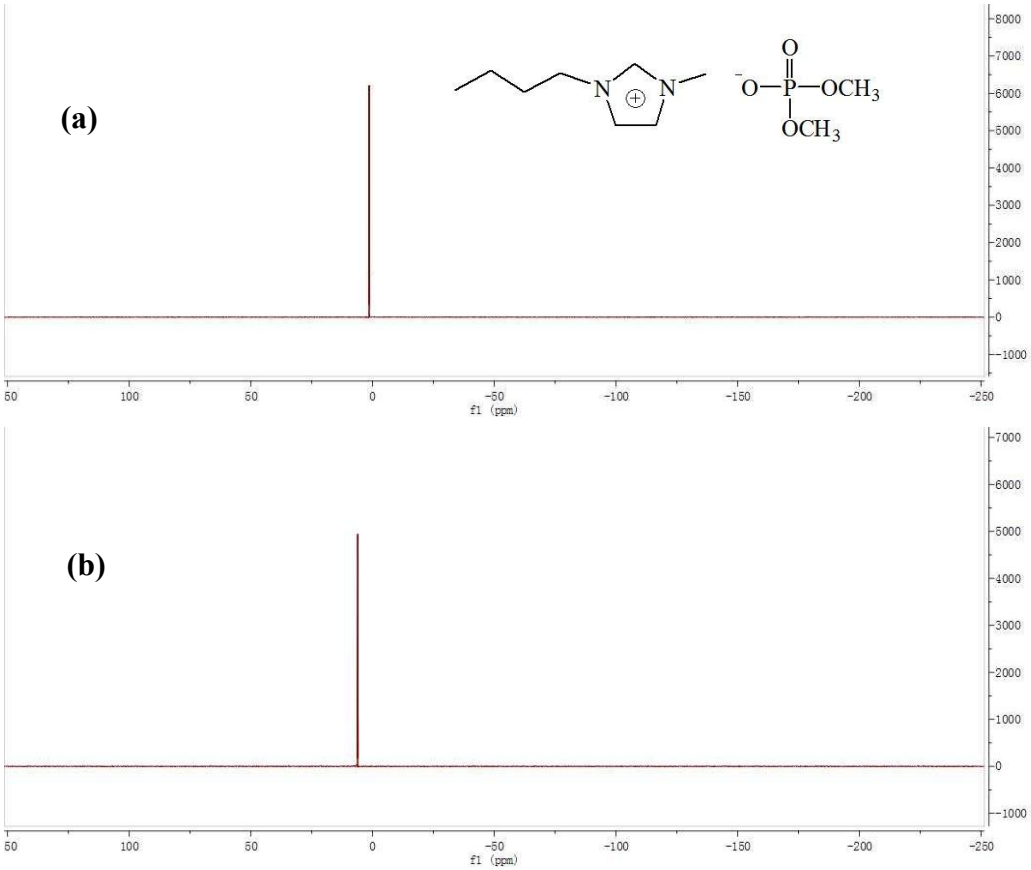


Figure S18 ^{31}P NMR spectra for $[C_4C_1im][DMP]$ (1-butyl-3-methylimidazolium dimethylphosphate): (a) fresh ionic liquid; (b) ionic liquid+NH_3.

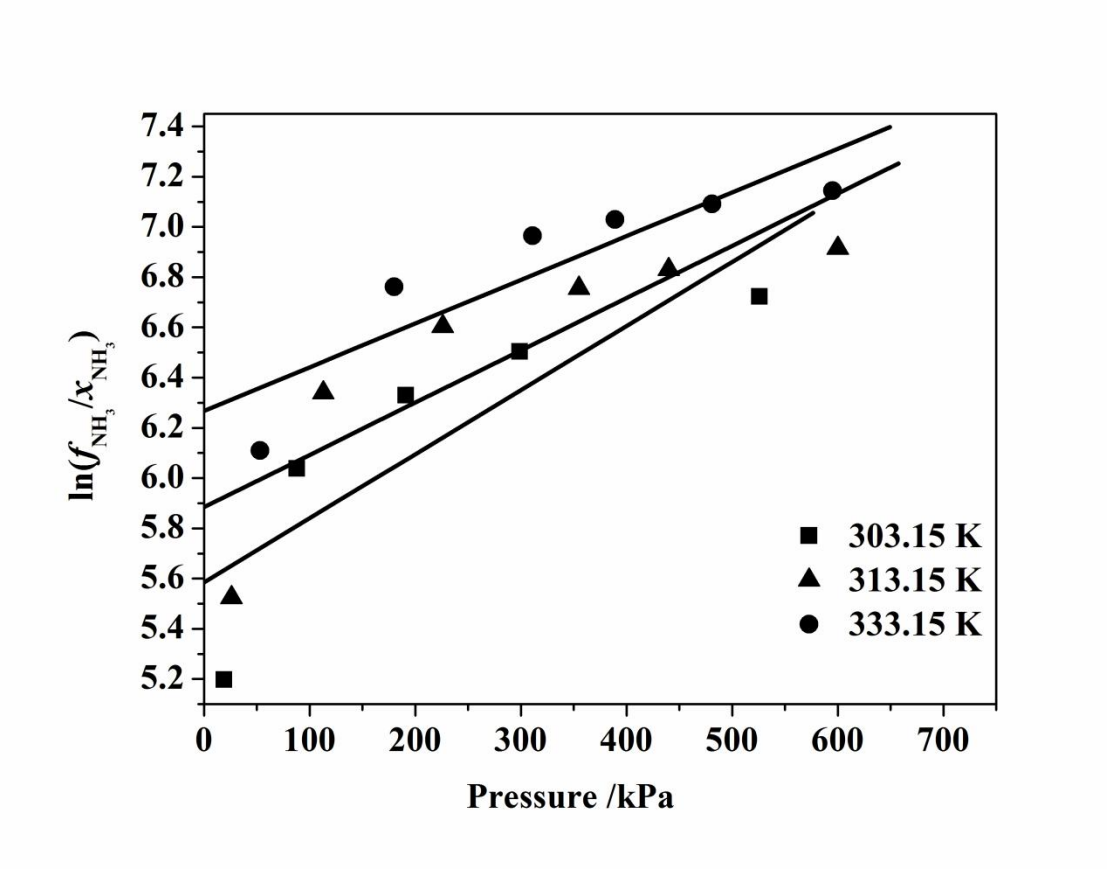


Figure S19 K-K equation analysis of the solubilities of NH_3 in $[C_4C_1im][DMP]$

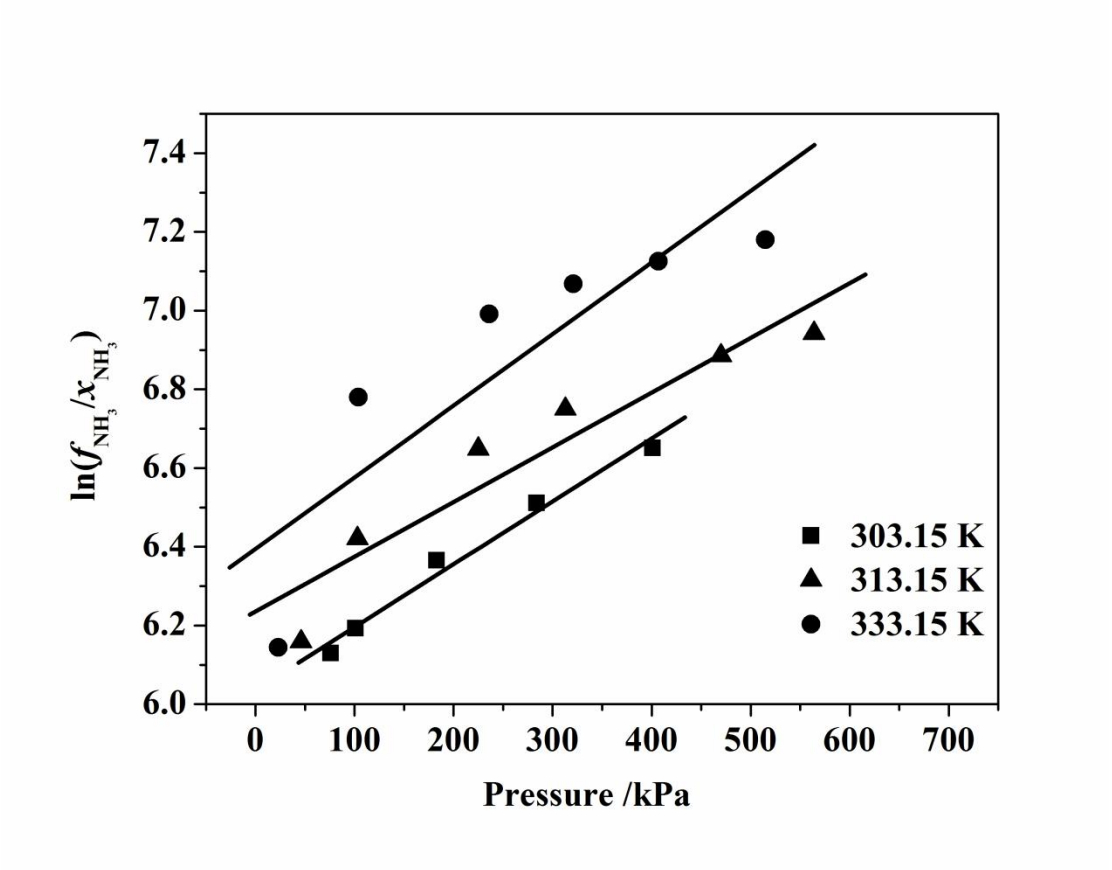


Figure S20 K-K equation analysis of the solubilities of NH_3 in $[C_2C_1im][DEP]$

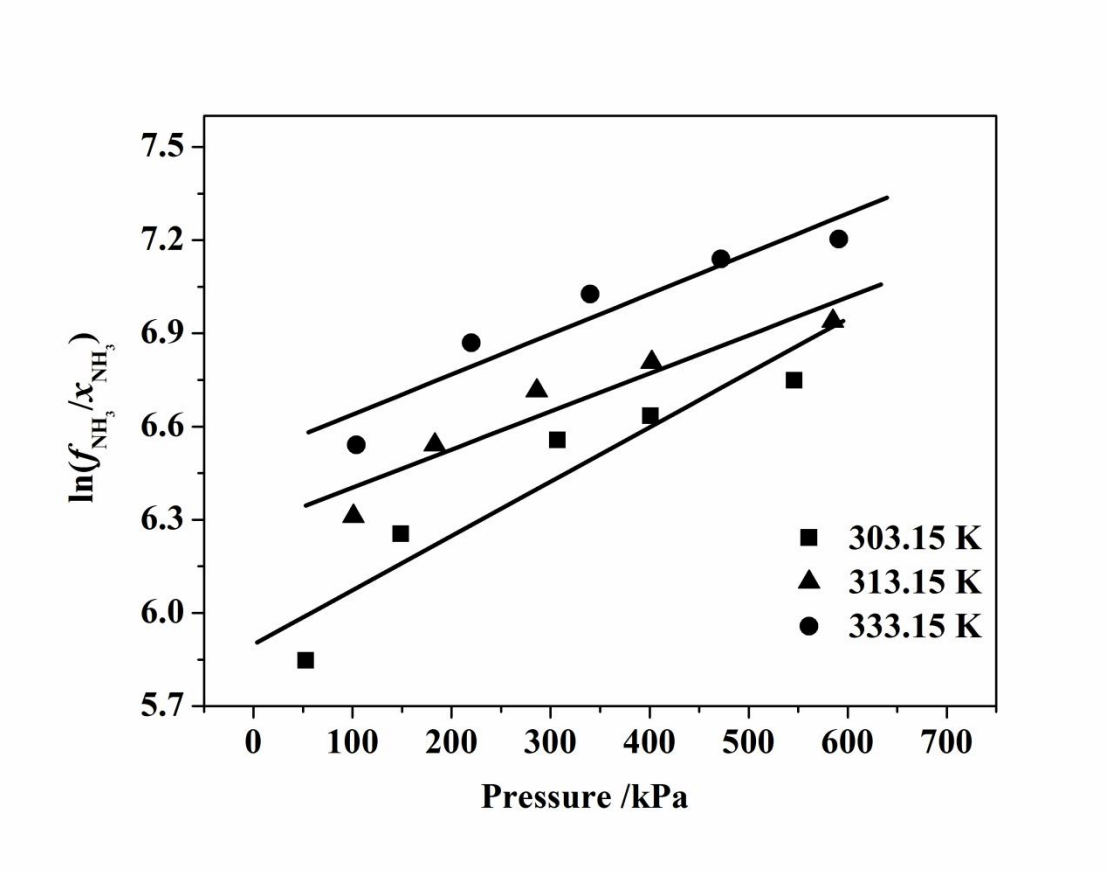


Figure S21 K-K equation analysis of the solubilities of NH_3 in $[C_2C_1im][DMP]$

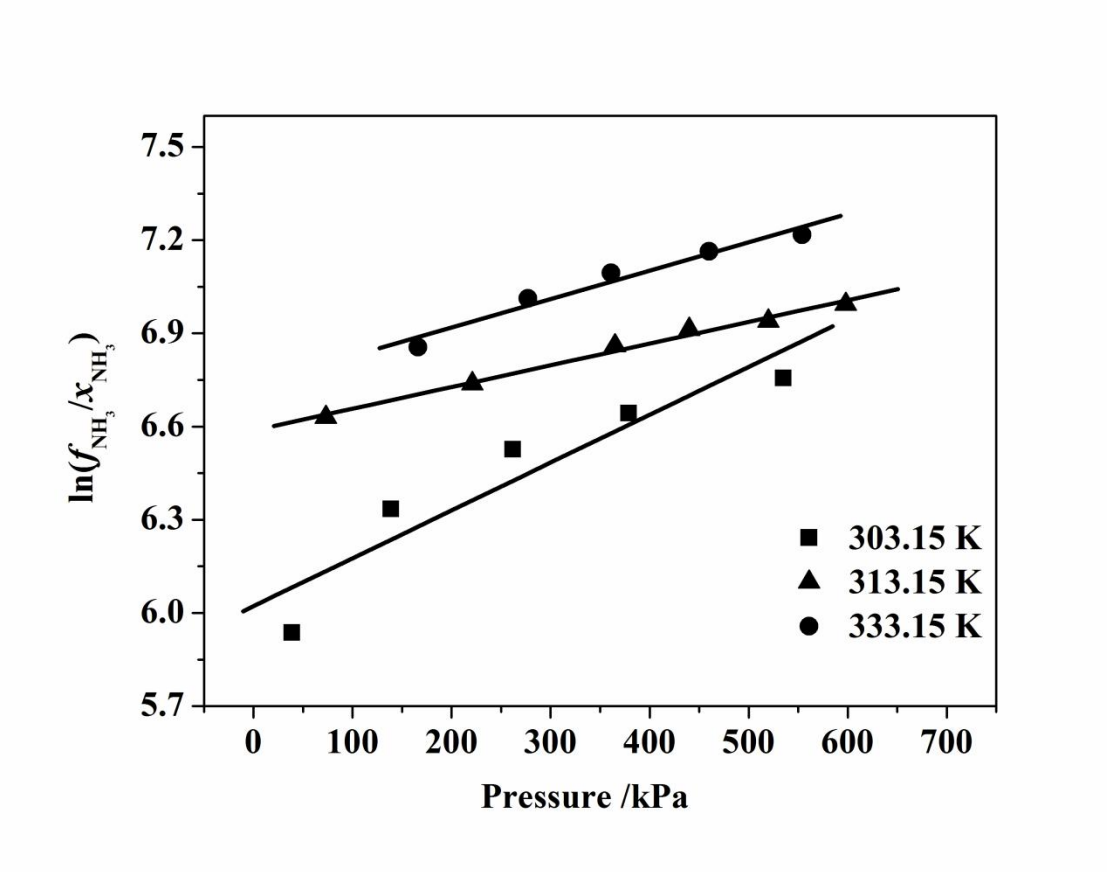


Figure S22 K-K equation analysis of the solubilities of NH_3 in $[C_1C_1im][DMP]$

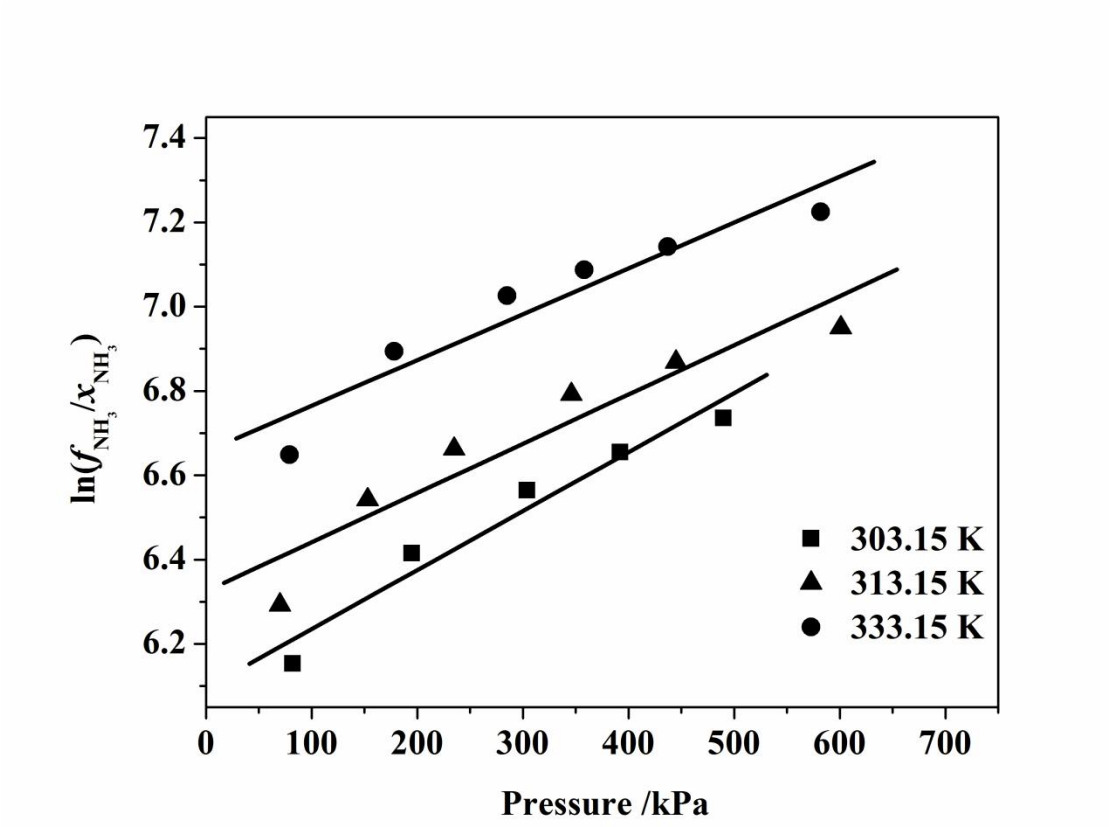


Figure S23 K-K equation analysis of the solubilities of NH_3 in $[C_4C_1im][DBP]$

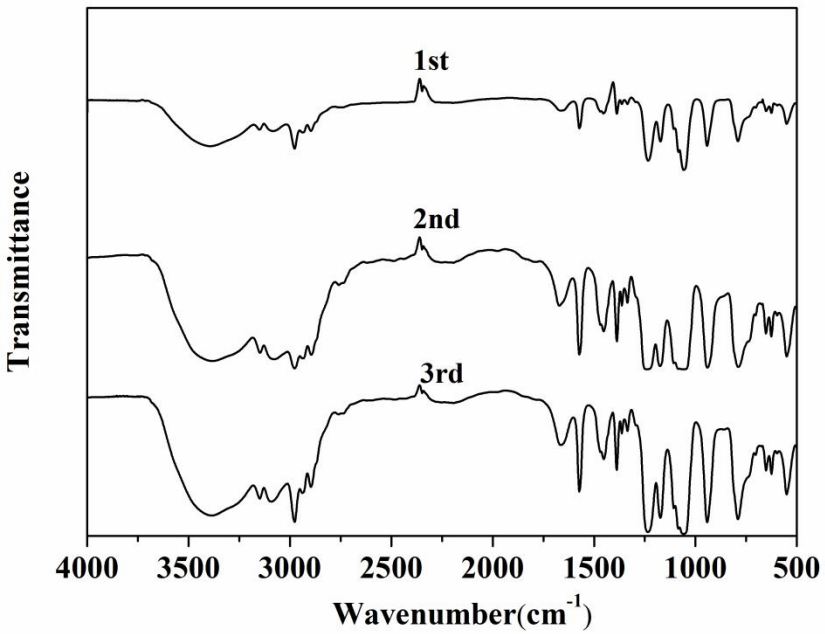


Figure S24 FT-IR spectra of three consecutive cycles of NH_3 absorption and desorption in $[C_2C_1im][DEP]$

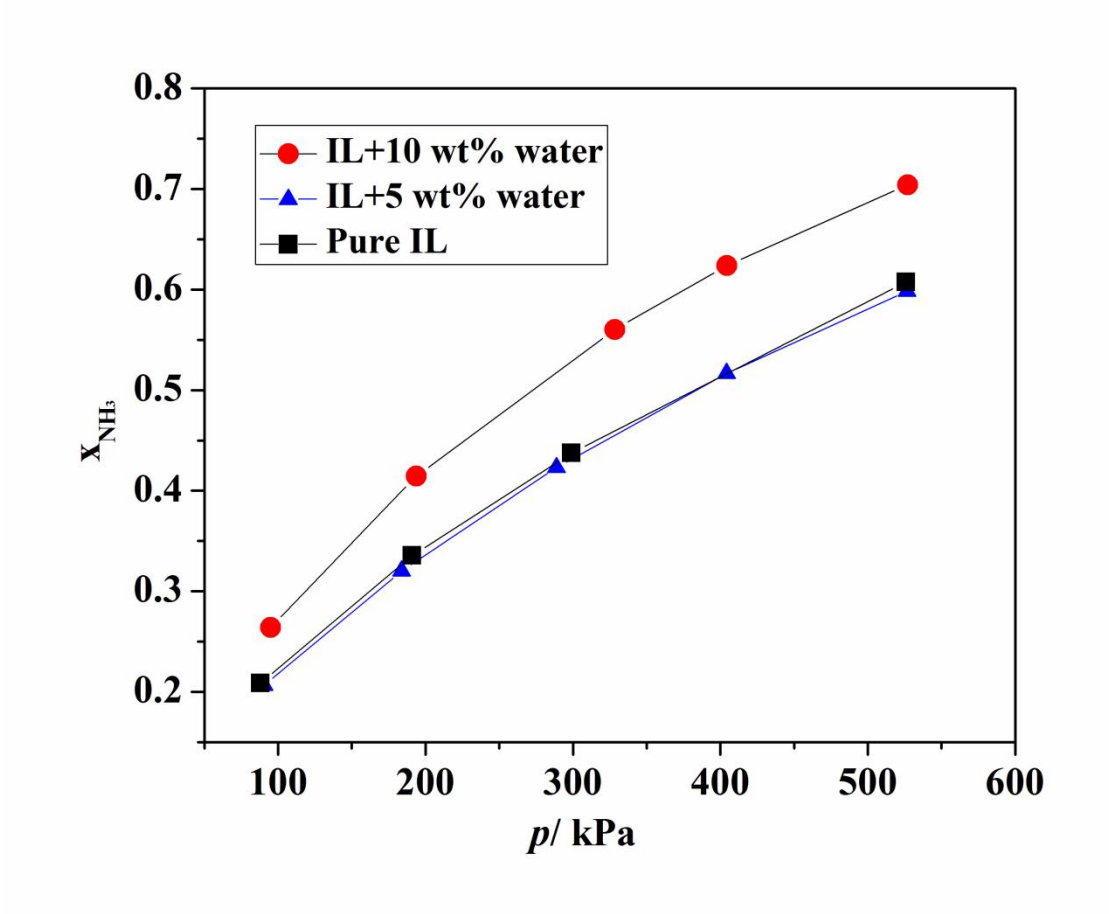


Figure S25 The effect of water on NH_3 absorption in [C_4C_1im][DMP] at 303.15 K