Supporting Information

Substantial enhancement of heavy crude oil dissolution in low waxy crude oil in the presence of ionic liquid

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Table S1: List of chemicals used for the present investigation

S.No	Chemical Name	CAS No	Source	Purity (%)
1	1-bromo butane	109-65-9	Spectrochem	98%
2	1-chloro butane	109-69-3	Spectrochem	99%
3	1-chloro octane	111-85-3	Sigma Aldrich	99%
4	1- methyl imidazole	616-47-7	Spectrochem	99%
5	Sulphuric acid	7664-93-9	Merck	98%
6	Acetic acid	64-19-7	Merck	99%
7	o-phosphoric acid[a]	7664-38-2	Merck	85%
8	Triethyl amine	121-44-8	Rankem	99.5%
9	Tripropyl amine	102-69-2	Spectrochem	98%
10	ε-Caprolactam	105-60-2	Sigma Aldrich	99%
11	γ-Butyrolactam	616-45-5	Sigma Aldrich	99%
12	Formic acid	64-18-6	Sigma Aldrich	95%
13	Hexanoic acid	142-62-1	Sigma Aldrich	99%

[a]- o-phosphoric acid in H_2O

Table S2: Standard calibration absorbances – Uv-vis absorption for the HCO:LWC (2:3 wt/wt) in different solvents such as (a) toluene, (b) hexane, (c) heptane, (d) decane at different concentrations (ppm) with its standard deviation.

HCO:LWC Conc.	Absorbance			
	toluene	hexane	heptane	decane
10	0.0595±0.00041	0.1913±0.00035	0.1825±0.00035	0.2108±0.00071
20	0.1356±0.00035	0.4235±0.00028	0.3853±0.00028	0.4538±0.00092
30	0.1924±0.00028	0.6542±0.00028	0.6145±0.00035	0.6715±0.00099
40	0.2715±0.00042	0.8585±0.00042	0.8141±0.00035	0.9112±0.00049
50	0.3251±0.00057	1.1023±0.00035	0.9914±0.00028	1.1485±0.00028
60	0.3909±0.00042	1.3147±0.00035	1.1824±0.00057	1.3979±0.00049
70	0.4508±0.00064	1.5644±0.00085	1.3916±0.00049	1.6315±0.00078
80	0.5348±0.00057	1.7579±0.00057	1.6315±0.00049	1.8778±0.00049
90	0.5979±0.00014	2.0112±0.00071	1.8346±0.00028	2.0811±0.00035
100	0.6546±0.00021	2.2411±0.00085	2.0515±0.00057	2.3341±0.00048

Table S3: Comparison of the efficiency of the ILs in terms of the increase in concentration of the ILs from 100 to 10000 ppm at different interval. Solubility of HCO in LWC (2:3 wt/wt) with the addition of IL at 298.15 K temperature for 60 min.

S. No	Ionic liquids	Concentration of ILs (ppm)				
		100	250	1000	5000	10000
1	[BMIM]+ [Cl]-	67.25	69.25	71.25	71.69	72.43
2	[BMIM]+ [Br]-	59.62	60.46	61.27	62.58	62.88
3	[BMIM]+[HSO4]-	61.24	63.24	63.99	64.56	65.14
4	[OMIM]+ [Cl]-	68.12	68.74	68.89	70.11	70.54
5	[Et3NH]+[HSO4]-	63.54	64.13	64.88	65.89	66.59
6	[Et3NH]+[H2PO4]-	57.35	57.86	58.19	58.81	59.74
7	[Et3NH]+[CH3COO]-	61.28	61.85	62.38	63.42	63.91
8	[Pr3NH]+[HSO4]-	66.29	67.34	67.59	68.86	69.14
9	[BT]+[HCOO]-	68.71	69.13	69.75	70.25	70.39
10	[BT]+[CH3COO]-	68.89	69.35	70.25	71.12	71.92
11	[BT]+[C6H13COO]-	69.26	70.42	71.14	72.65	73.33
12	[CP]+[HCOO]-	71.26	72.81	74.03	74.82	75.34

The standard uncertainties are $u(T) = 0.4$ K, $u(solubility\ of\ HCO) = \leq 1.20$ %, $u(IL\ conc.) = 1$ ppm.

Table S4: Comparison of the efficiency of the ILs in terms of the increase in dissolution time from 15 to 300 mins at different interval. Solubility of HCO in LWC (2:3 wt/wt) with the addition of 100 ppm IL at 298.15 K temperature.

S. No	Ionic liquids	Reaction time (min)				
		15	30	60	120	300
1	Without ILs	34.23	36.52	41.5	42.3	44.15
2	[BMIM]+ [Cl]-	51.23	54.29	67.25	68.78	70.26
3	[BMIM]+ [Br]-	49.26	56.34	59.62	60.13	61.74
4	[BMIM]+[HSO4]-	46.28	54.85	61.24	63.02	63.41
5	[OMIM]+ [Cl]-	53.26	58.39	68.12	68.45	69.13
6	[Et3NH]+[HSO4]-	45.85	52.52	63.54	64.38	65.02
7	[Et3NH]+[H2PO4]-	51.36	55.96	57.35	58.06	58.74
8	[Et3NH]+[CH3COO]-	44.38	52.84	61.28	61.89	62.44
9	[Pr3NH]+[HSO4]-	50.74	57.26	66.29	67.13	68.78
10	[BT]+[HCOO]-	46.38	59.36	68.71	69.33	71.32
11	[BT]+[CH3COO]-	53.69	61.84	68.89	70.17	71.86
12	[BT]+[C6H13COO]-	51.22	58.95	69.26	71.01	72.56
13	[CP]+[HCOO]-	55.29	63.25	71.26	73.26	74.89

The standard uncertainties are $u(T) = 0.4$ K, $u(solubility\ of\ HCO) = \leq 1.20$ %, $u(IL\ conc.) = 1$ ppm.

Table S5: Comparison of efficiency of the present crude oil dissolution method with the previously available methods.

Surfactant/ILs		Surfactant/ILs concentrations (ppm)						References
	100	250	500	1000	2000	5000	10000	

Rhamnolipid	-	-	-	44	-	-	-	[35]
Saponin	-	-	-	27	-	-	-	
sodium dodecyl sulphate	-	-	-	46	-	-	-	
Rhamnolipid	-	-	40	-	63	-	-	[36]
Surfactin	-	-	27	-	62	-	-	
Serrawettin	-	-	22	-		-	-	
Triton X-100	-	-	-	-	40	-	-	
Tween 80	-	-	-	-	35	-	-	
$[BMIM]^+[Cl]^-$	67.25	69.25	-	71.25	-	71.69	72.43	This work
$[BMIM]^+[Br]^-$	59.62	60.46	-	61.27	-	62.58	62.88	
$[BMIM]^+[HSO_4]^-$	61.24	63.24	-	63.99	-	64.56	65.14	
$[OMIM]^+[Cl]^-$	68.12	68.74	-	68.89	-	70.11	70.54	
$[Et_3NH]^+[HSO_4]^-$	63.54	64.13	-	64.88	-	65.89	66.59	
$[Et_3NH]^+[H_2PO_4]^-$	57.35	57.86	-	58.19	-	58.81	59.74	
$[Et_3NH]^+[CH_3COO]^-$	61.28	61.85	-	62.38	-	63.42	63.91	
$[Pr_3NH]^+[HSO_4]^-$	66.29	67.34	-	67.59	-	68.86	69.14	
$[BT]^+[HCOO]^-$	68.71	69.13	-	69.75	-	70.25	70.39	
$[BT]^+[CH_3COO]^-$	68.89	69.35	-	70.25	-	71.12	71.92	
$[BT]^+[C_6H_{13}COO]^-$	69.26	70.42	-	71.14	-	72.65	73.33	
$[CP]^+[HCOO]^-$	71.26	72.81	-	74.03	-	74.82	75.34	
100% toluene	98.8							[37]
75% toluene+25% diesel	90.4							
50% toluene+50% diesel	75.6							
25% toluene+75% diesel	38.4							
100% diesel	13.2							
50% heptane+50% toluene	≥ 97							[7]
40% heptane+60% toluene	≥95							[8]

Table S6: UV-vis absorbance values comparison of standard (without IL) and sample solution (with 100 ppm of ILs) of the HCO:LWC (in 2:3 wt/wt) crude oil in toluene in four different concentrations of HCO:LWC (2:3 wt/wt)crude oil.

S.No	Ionic Liquids	Absorbance			
		10ppm	30ppm	50ppm	70ppm
	Calibration (Standard)	0.0595	0.1924	0.3251	0.4508
1	$[BMIM]^+[Cl]^-$	0.0721	0.2347	0.3945	0.5468
2	$[BMIM]^+[Br]^-$	0.0657	0.2145	0.3623	0.4925
3	$[BMIM]^+[HSO_4]^-$	0.0703	0.2314	0.3946	0.5507
4	$[OMIM]^+[Cl]^-$	0.0733	0.2453	0.4159	0.5746
5	$[Et_3NH]^+[HSO_4]^-$	0.0668	0.2189	0.3681	0.5124
6	$[Et_3NH]^+[H_2PO_4]^-$	0.0671	0.2094	0.3568	0.4933
7	$[Et_3NH]^+[CH_3COO]^-$	0.0717	0.2374	0.4028	0.5543
8	$[Pr_3NH]^+[HSO_4]^-$	0.0684	0.2196	0.3845	0.5294
9	$[BT]^+[HCOO]^-$	0.0704	0.2364	0.4059	0.5623
10	$[BT]^+[CH_3COO]^-$	0.0713	0.2423	0.4078	0.5668
11	$[BT]^+[C_6H_{13}COO]^-$	0.0722	0.2471	0.4186	0.5781

12	$[CP]^+[HCOO]^-$	0.0744	0.2502	0.4215	0.5864

The standard uncertainties are $u(T)$ = 0.2 K, $u(absorbance)$ = 0.001, $u(HCO{:}LWC\ conc.)$ = 1 ppm.

Table S7: UV-vis absorbance values comparison of standard (without IL) and sample solution (with 100 ppm of ILs) of the HCO:LWC (in 2:3 wt/wt) crude oil in hexane in four different concentrations of HCO:LWC (2:3 wt/wt) crude oil.

S.No	Ionic Liquids	Absorbance			
		10ppm	30ppm	50ppm	70ppm
	Calibration (Standard)	0.1913	0.6542	1.1023	1.5644
1	$[BMIM]^+[Cl]^-$	0.2493	0.8169	1.3125	1.8157
2	$[BMIM]^+[Br]^-$	0.2159	0.7359	1.2148	1.7152
3	$[BMIM]^+[HSO_4]^-$	0.2386	0.8059	1.3358	1.8259
4	$[OMIM]^+[Cl]^-$	0.2514	0.8359	1.3659	1.8425
5	$[Et_3NH]^+[HSO_4]^-$	0.2231	0.7496	1.2381	1.7548
6	$[Et_3NH]^+[H_2PO_4]^-$	0.2185	0.7368	1.2356	1.7359
7	$[Et_3NH]^+[CH_3COO]^-$	0.2374	0.7954	1.3125	1.8025
8	$[Pr_3NH]^+[HSO_4]^-$	0.2314	0.7659	1.2890	1.7586
9	$[BT]^+[HCOO]^-$	0.2534	0.8549	1.3724	1.8529
10	$[BT]^+[CH_3COO]^-$	0.2551	0.8586	1.3785	1.8591
11	$[BT]^+[C_6H_{13}COO]^-$	0.2561	0.8615	1.3816	1.8629
12	$[CP]^+[HCOO]^-$	0.2625	0.8695	1.3856	1.8694

The standard uncertainties are $u(T)$ = 0.2 K, $u(absorbance)$ = 0.001, $u(HCO{:}LWC\ conc.)$ = 1 ppm.

Table S8: UV-vis absorbance values comparison of standard (without IL) and sample solution (with 100 ppm of ILs) of the HCO:LWC (in 2:3 wt/wt) crude oil in heptane in four different concentrations of HCO:LWC (2:3 wt/wt) crude oil.

.No	Ionic Liquids	Absorbance			
		10ppm	30ppm	50ppm	70ppm
	Calibration (Standard)	0.1825	0.6145	0.9914	1.3916
1	$[BMIM]^+[Cl]^-$	0.2431	0.8186	1.3196	1.8593
2	$[BMIM]^+[Br]^-$	0.2271	0.7623	1.2348	1.7366
3	$[BMIM]^+[HSO_4]^-$	0.2426	0.8155	1.3269	1.8563
4	$[OMIM]^+[Cl]^-$	0.2472	0.8269	1.3428	1.8792
5	$[Et_3NH]^+[HSO_4]^-$	0.2275	0.7639	1.2369	1.7356
6	$[Et_3NH]^+[H_2PO_4]^-$	0.2213	0.7486	1.2158	1.6892
7	$[Et_3NH]^+[CH_3COO]^-$	0.2314	0.7786	1.2506	1.7569
8	$[Pr_3NH]^+[HSO_4]^-$	0.2289	0.7712	1.2456	1.7458
9	$[BT]^+[HCOO]^-$	0.2493	0.8378	1.3575	1.9056
10	$[BT]^+[CH_3COO]^-$	0.2496	0.8408	1.3592	1.9086

11	$[BT]^+[C_6H_{13}COO]^-$	0.2501	0.8426	1.3615	1.9113
12	$[CP]^+[HCOO]^-$	0.2513	0.8456	1.3652	1.9125

The standard uncertainties are $u(T)$ = 0.2 K, $u(absorbance)$ = 0.001, $u(HCO{:}LWC\ conc.)$ = 1 ppm.

Table S9: UV-vis absorbance values comparison of standard (without IL) and sample solution (with 100 ppm of ILs) of the HCO:LWC (in 2:3 wt/wt) crude oil in decane in four different concentrations of HCO:LWC (2:3 wt/wt) crude oil.

S.No	Ionic Liquids	Absorbance			
		10ppm	30ppm	50ppm	70ppm
	Calibration (Standard)	0.2108	0.6715	1.1485	1.6315
1	$[BMIM]^+[Cl]^-$	0.2431	0.7729	1.3257	1.8798
2	$[BMIM]^+[Br]^-$	0.2356	0.7482	1.2869	1.8215
3	$[BMIM]^+[HSO_4]^-$	0.2435	0.7711	1.3266	1.8802
4	$[OMIM]^+[Cl]^-$	0.2459	0.7733	1.3289	1.8813
5	$[Et_3NH]^+[HSO_4]^-$	0.2305	0.7346	1.2526	1.7896
6	$[Et_3NH]^+[H_2PO_4]^-$	0.2221	0.7124	1.2105	1.7234
7	$[Et_3NH]^+[CH_3COO]^-$	0.2371	0.7489	1.2815	1.8235
8	$[Pr_3NH]^+[HSO_4]^-$	0.2314	0.7398	1.2531	1.7936
9	$[BT]^+[HCOO]^-$	0.2445	0.7801	1.3328	1.8974
10	$[BT]^+[CH_3COO]^-$	0.2447	0.7814	1.3334	1.8989
11	$[BT]^+[C_6H_{13}COO]^-$	0.2451	0.7825	1.3346	1.9013
12	$[CP]^+[HCOO]^-$	0.2466	0.7856	1.3359	1.9025

The standard uncertainties are $u(T)$ = 0.2 K, $u(absorbance)$ = 0.001, $u(HCO{:}LWC\ conc.)$ = 1 ppm.

Table S10: Comparing the IFT results of this present study (*twelve* ILs) with the reported IFT values of water and crude oil+water systems upon addition of IL/surfactants.

IFT (mN/m)	ILs/Surfactant concentration (ppm)						Reference
	0	100	250	500	750	1000	
$[C_{12}mim]^+[Cl]^-$	39.98	37.59	-	-	-	28.44	[43]
$[C_8Py]^+[Cl]^-$	39.98	38.49	35.82	31.68	30.21	29.53	[44]
$[C_{12}Py]^+[Cl]^-$	39.98	37.12	33.50	8.72	7.42	7.38	
$[C_8mim]^+[Cl]^-$	39.98	38.77	35.77	34.55	29.87	16.77	
$[C_{12}mim]^+[Cl]^-$	39.98	37.59	34.21	32.36	29.12	28.44	
$[C_{12}mim]^+[Cl]^-$	47.30	45.2	-	-	-	43.3	[45]
$[BMIM]^+[Cl]^-$	37.15	26.35	-	-	-	-	This work
$[BMIM]^+[Br]^-$	37.15	27.86	-	-	-	-	
$[BMIM]^+[HSO_4]^-$	37.15	26.51	-	-	-	-	
$[OMIM]^+[Cl]^-$	37.15	26.06	-	-	-	-	
$[Et_3NH]^+[HSO_4]^-$	37.15	26.88	-	-	-	-	
$[Et_3NH]^+[H_2PO_4]^-$	37.15	27.56	-	-	-	-	
$[Et_3NH]^+[CH_3COO]^-$	37.15	26.55	-	-	-	-	
$[Pr_3NH]^+[HSO_4]^-$	37.15	25.96	-	-	-	-	
$[BT]^+[HCOO]^-$	37.15	24.16	-	-	-	-	

$[BT]^+[CH_3COO]^-$	37.15	22.59	-	-	-	-	
$[BT]^+[C_6H_{13}COO]^-$	37.15	21.96	-	-	-	-	
$[CP]^+[HCOO]^-$	37.15	20.18	-	-	-	-	
Zonyl FSE	24.57	-	-	~ 16	-	-	[46]
Triton X-100	24.57	-	-	~ 2	-	-	
Triton X-405	24.57	-	-	~ 8	-	-	

Ionic Liquids Synthesis Procedure:

All the ionic liquids were synthesized by neutralization of equimolar base with the corresponding acid. In a 500 mL round-bottomed flask one equivalent of base was taken and placed in an oil-bath at the required temperature as per the previous literatures, fitted with a reflux condenser. To the above base, the corresponding acid solution (one equivalent) was slowly added drop-wise with vigorous stirring for about 1 hour. Then the reaction mixture was stirred for 2-4 hours at 70 ˚C to ensure completion of the reaction. Water was removed from the reaction mixture by heating the residue at 80 ˚C in high vacuum till the weight of the residue remained constant. The residual product was involved to recording the ^{1}H-NMR spectroscopy to ensure the structure and purity of the synthesized ionic liquids.

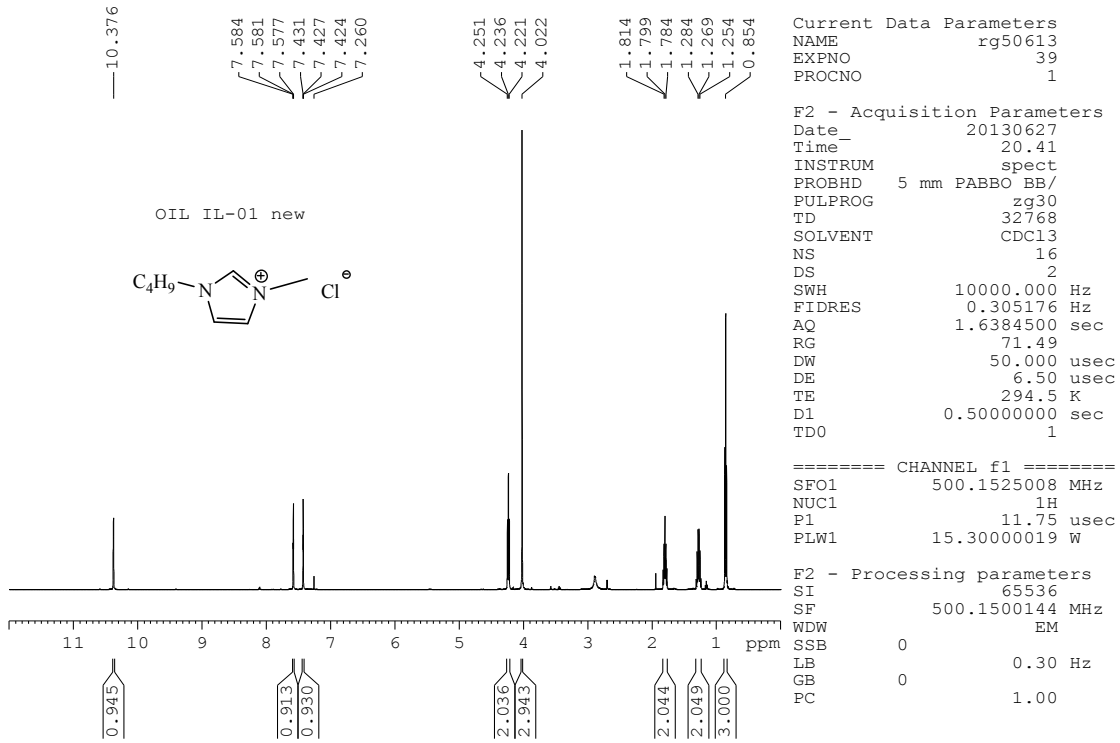

Figure S1: 1-butyl-3-methyl imidazolium chloride

Spectral data: ^{1}H NMR ($CDCl_3$-d): δ (ppm) 0.854 (t,3H), 1.26 (m,2H), 1.79 (m,2H), 4.02 (s,3H), 4.23 (m, 2H), 7.42 (m, 1H), 7.58 (m,1H), 10.37 (s,1H).

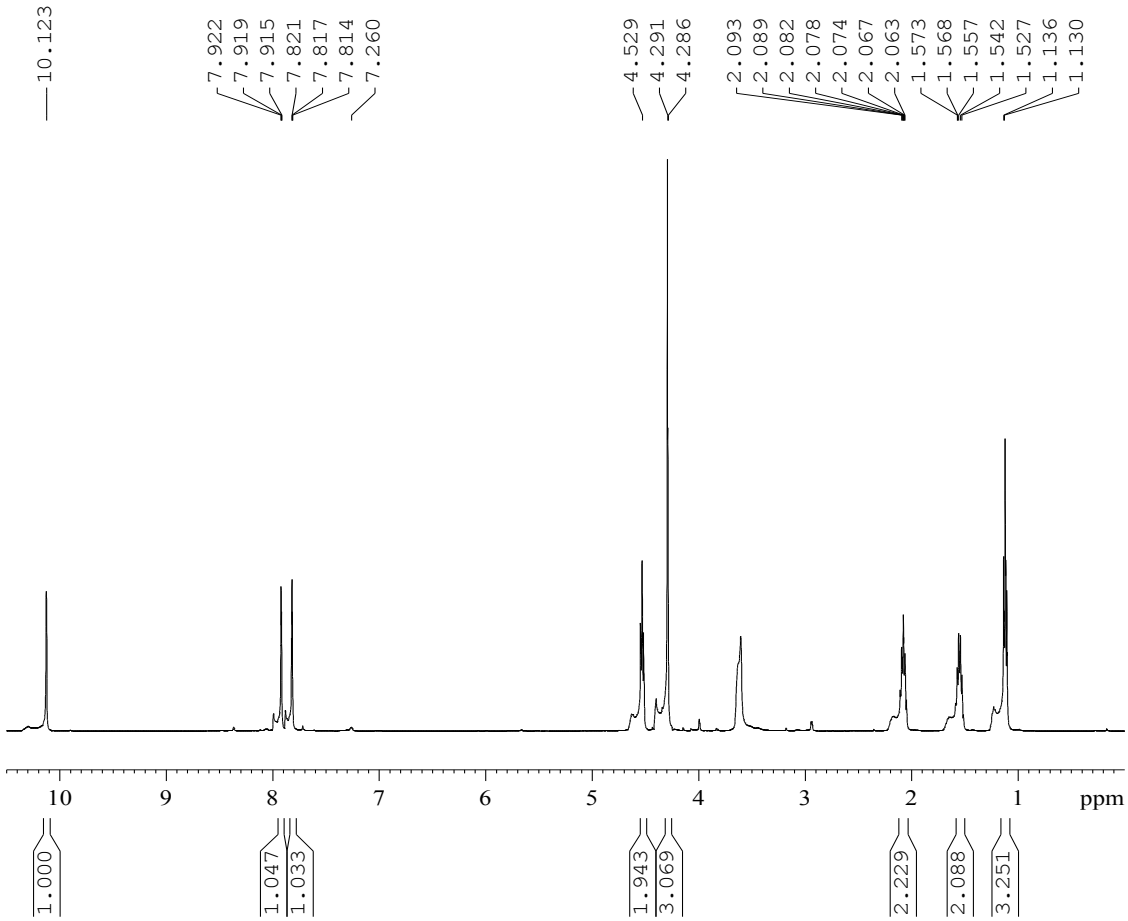

Figure S2: 1-Butyl-3-methylimidazolium Bromide

Spectral data: ^{1}H NMR(DMSO-d_6):1.13(t,3H), 1.56(m,2H), 2.08(m,2H), 4.29(s,3H), 4.53(m,2H), 7.81(m,1H), 7.91(m,1H), 10.12(s,1H).

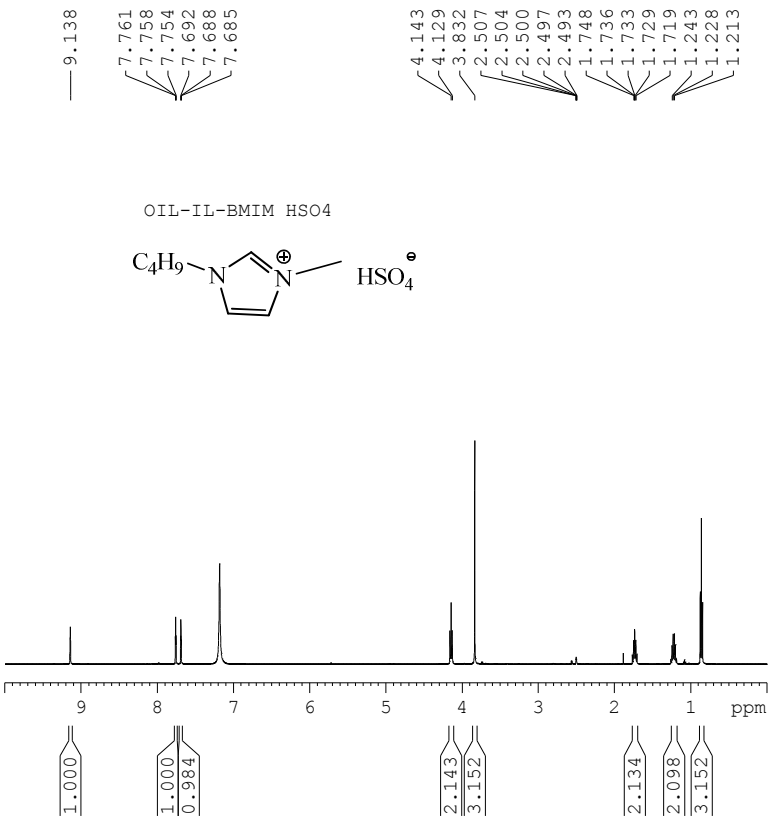


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Figure S3: 1-Butyl-3-methylimidazolium Hydrogen Sulphate

Spectral data: ^{1}H NMR(DMSO-d_6): 0.89 (t,3H), 1.22(m,2H), 1.73(m,2H), 3.83(s,3H), 4.13(m,2H), 7.68(m,1H), 7.75(m,1H), 9.13(s,1H).

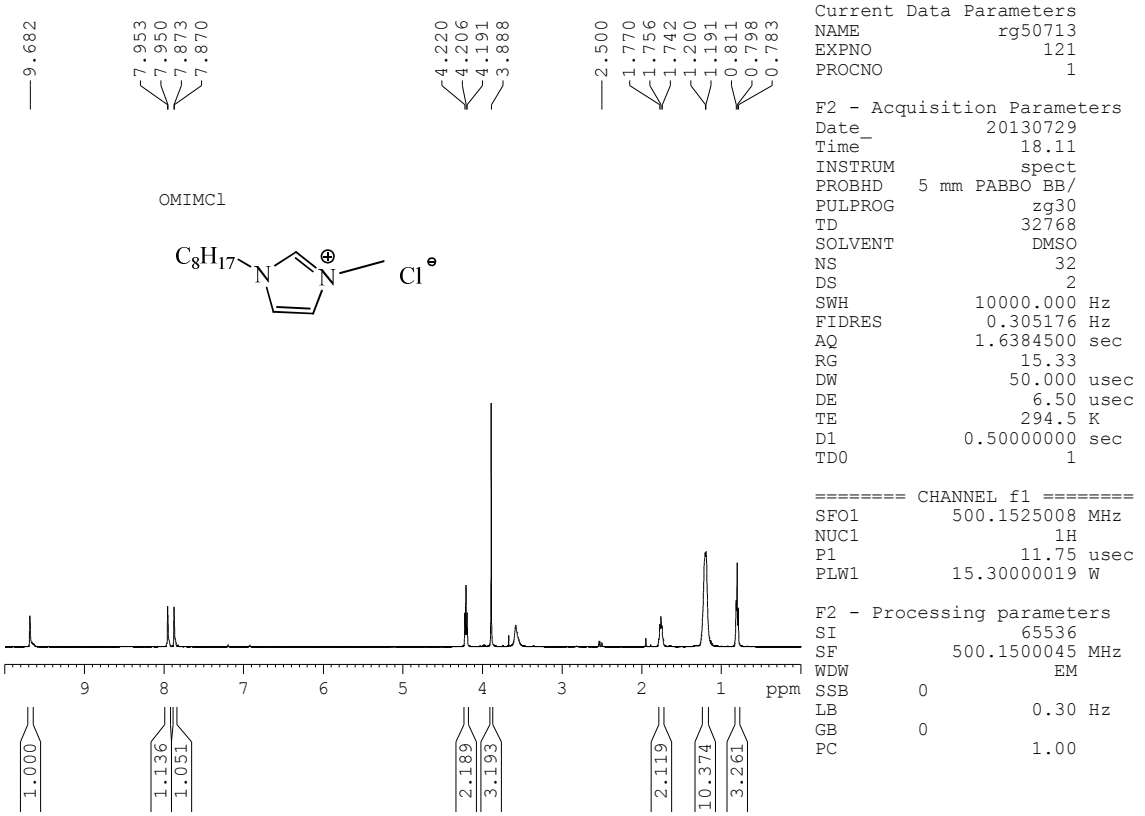


Figure S4: 1- Octyl-3-methylimidazolium Chloride

Spectral data: ^{1}H NMR(DMSO-d_6): 0.79(t,3H), 1.20(m,10H), 1.75(m,2H), 3.88(s,3H), 4.20(t,2H), 7.87(m,1H), 7.95(m,1H), 9.68(s,1H).

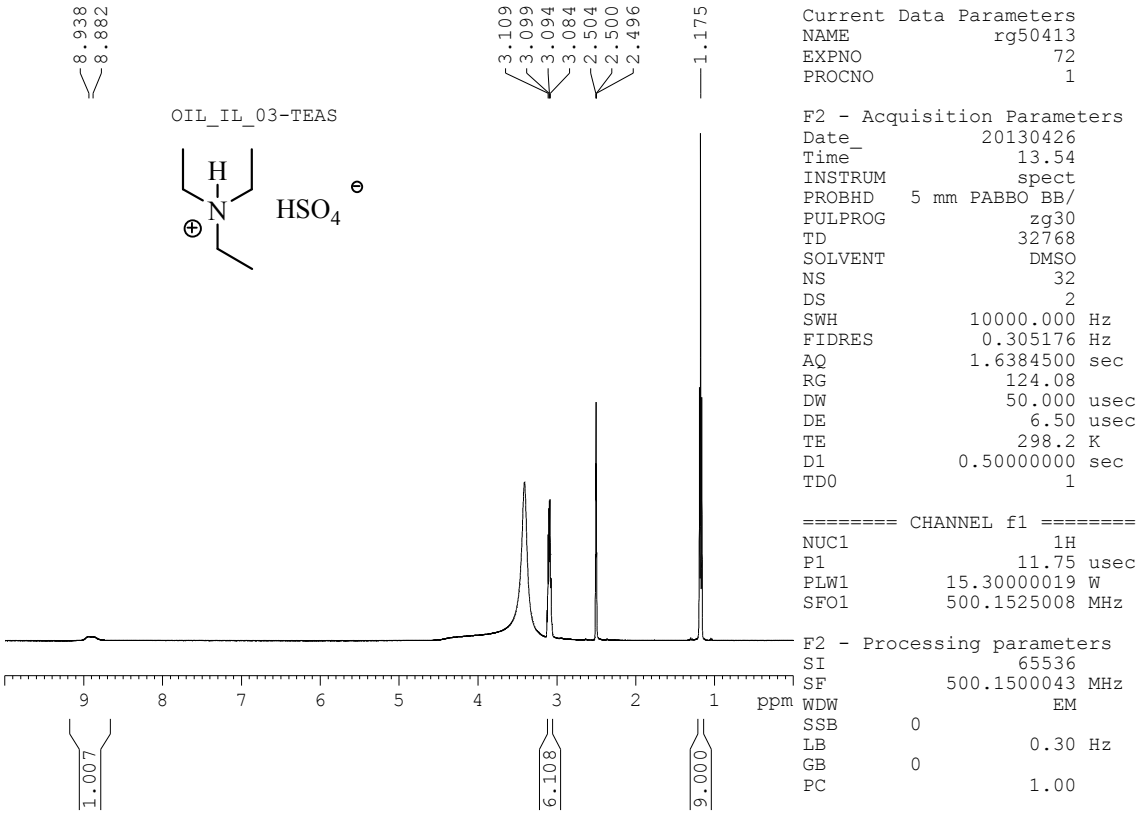
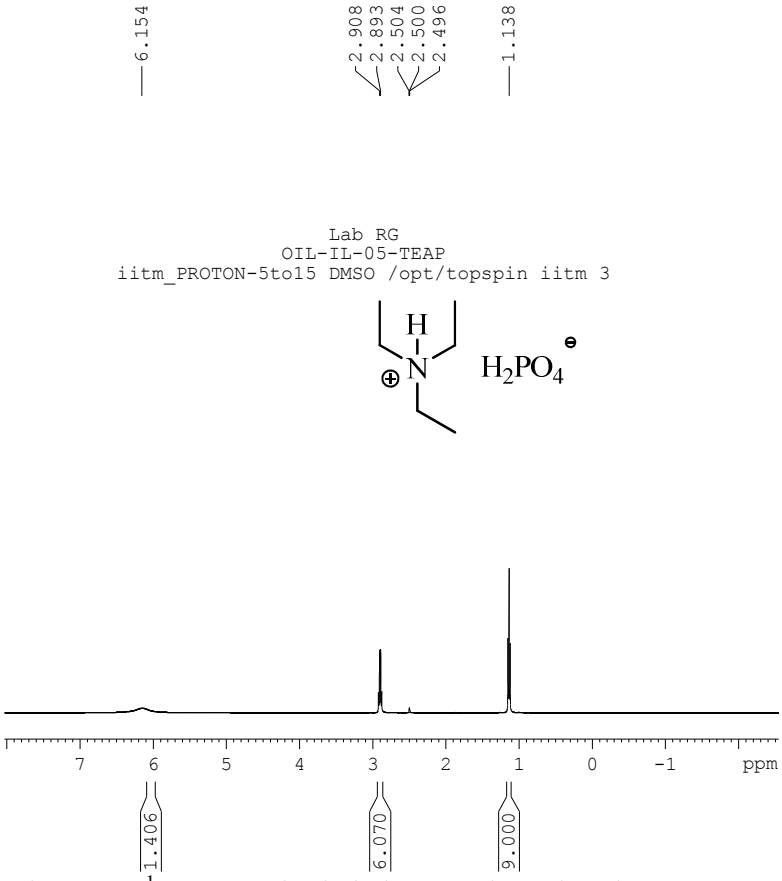


Figure S5: ^{1}H NMR of Triethyl ammonium sulfate
Spectral data: ^{1}H NMR (DMSO-d6): 1.17 (m,9H), 3.09 (m,6H), 8.90 (m,1H).

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DW                50.000 usec
DE                  6.50 usec
TE                 295.1 K
D1            0.50000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                  11.75 usec
PLW1         15.30000019 W
SFO1         500.1525008 MHz

F2 - Processing parameters
SI                  65536
SF          500.1500042 MHz
WDW                    EM
SSB       0
LB                   0.30 Hz
GB        0
PC                   1.00
```

Figure S6: ^{1}H NMR of Triethyl ammonium phosphate

Spectral data: ^{1}H NMR (DMSO-d_6): 1.138 (t,9H), 2.90 (m,6H), 6.14 (s,1H).

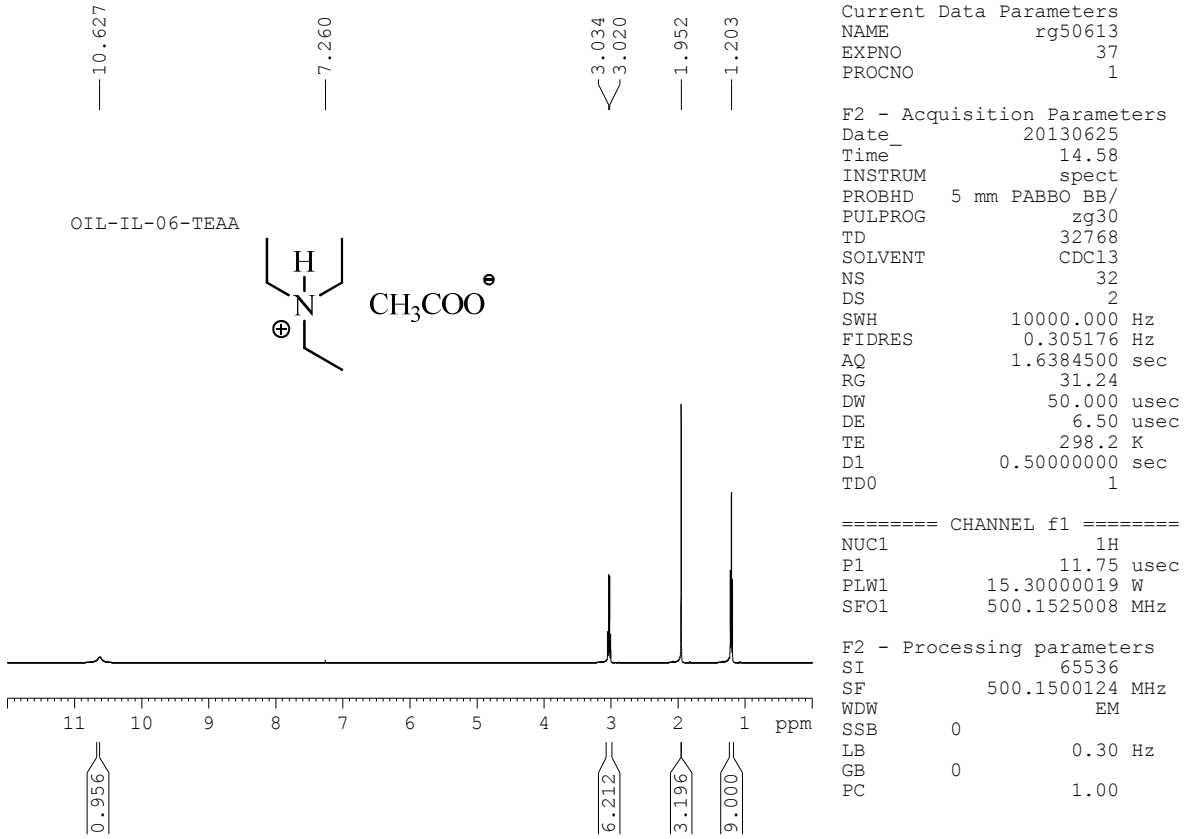


Figure S7: ^{1}H NMR of Triethyl ammonium acetate
Spectral data: ^{1}H NMR (DMSO-d_6): 1.20(t,9H), 1.92(m,3H), 3.03(m,6H), 10.62(s,1H).

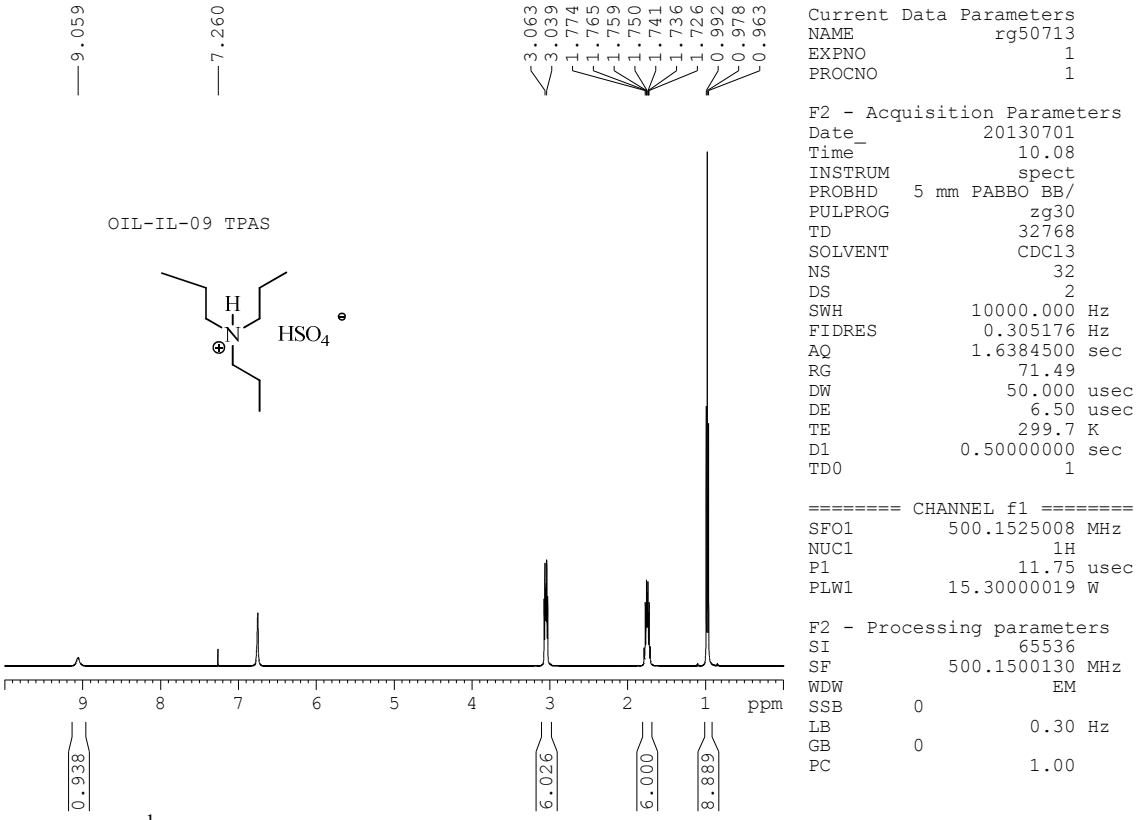


Figure S8: ^{1}H NMR of Tripropyl ammonium sulfate

Spectral data: ^{1}H NMR ($CDCl_3$-d): 0.97 (t,9H), 1.75 (m,6H), 3.05 (m,6H), 9.059 (s,1H).

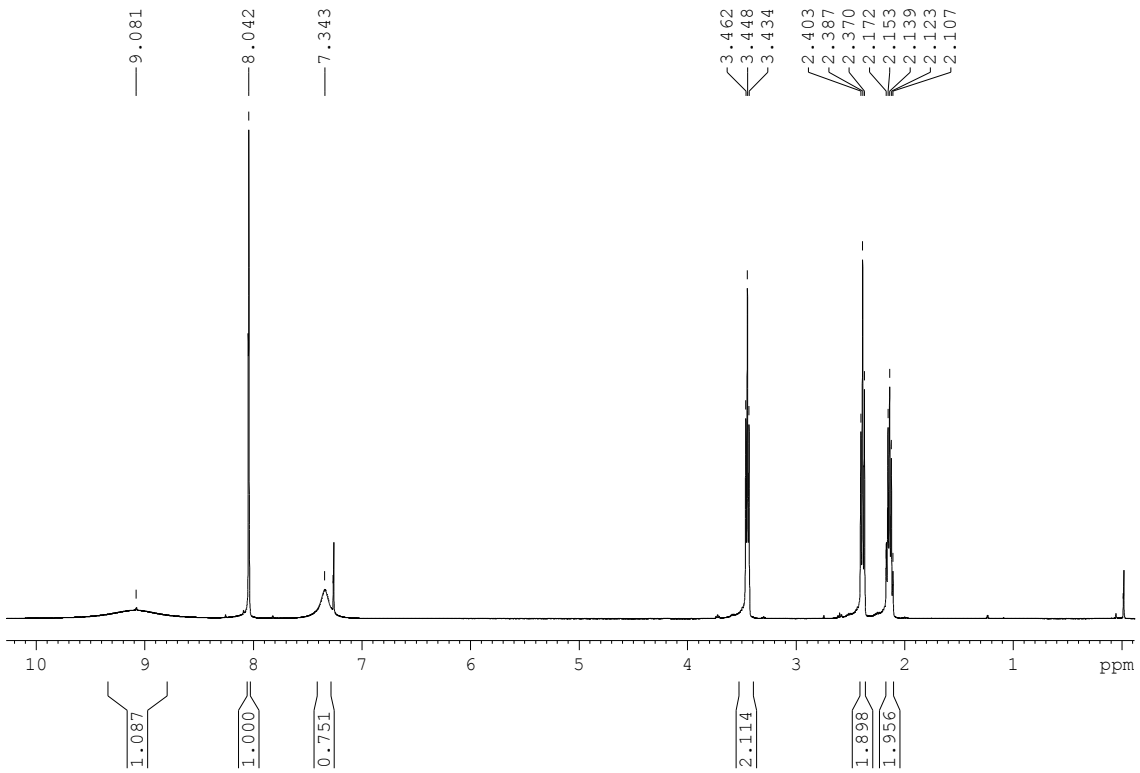


Figure S9: Butyrolactam formate

Spectral data: ^{1}H NMR($CDCl_3$-d): 2.15(2H), 2.38(m,2H), 3.44(m,2H), 7.34(s,1H), 8.04(s,1H), 9.08(b,1H).

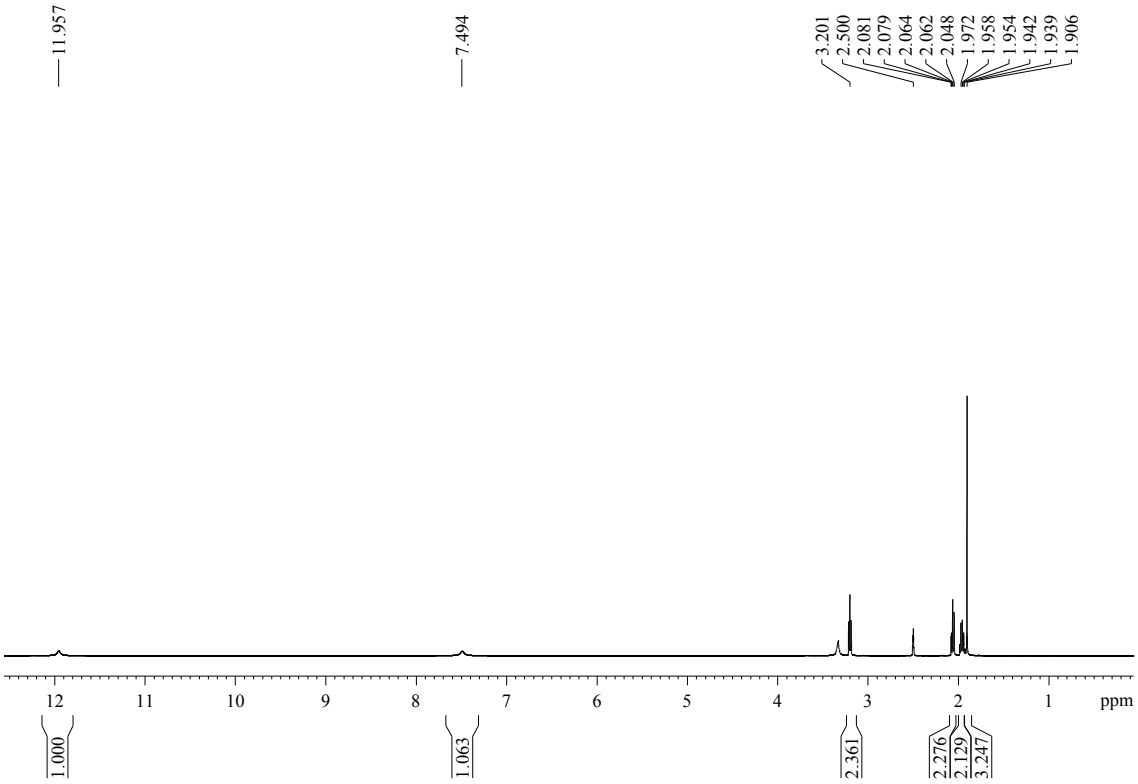


Figure S10: Butyrolactam acetate

Spectral data: ^{1}H NMR(DMSO-d_6): 1.92(m,3H), 1.97(m,2H), 2.05(m,2H), 3.20(m,2H), 7.49(s,1H), 11.96(b,1H).

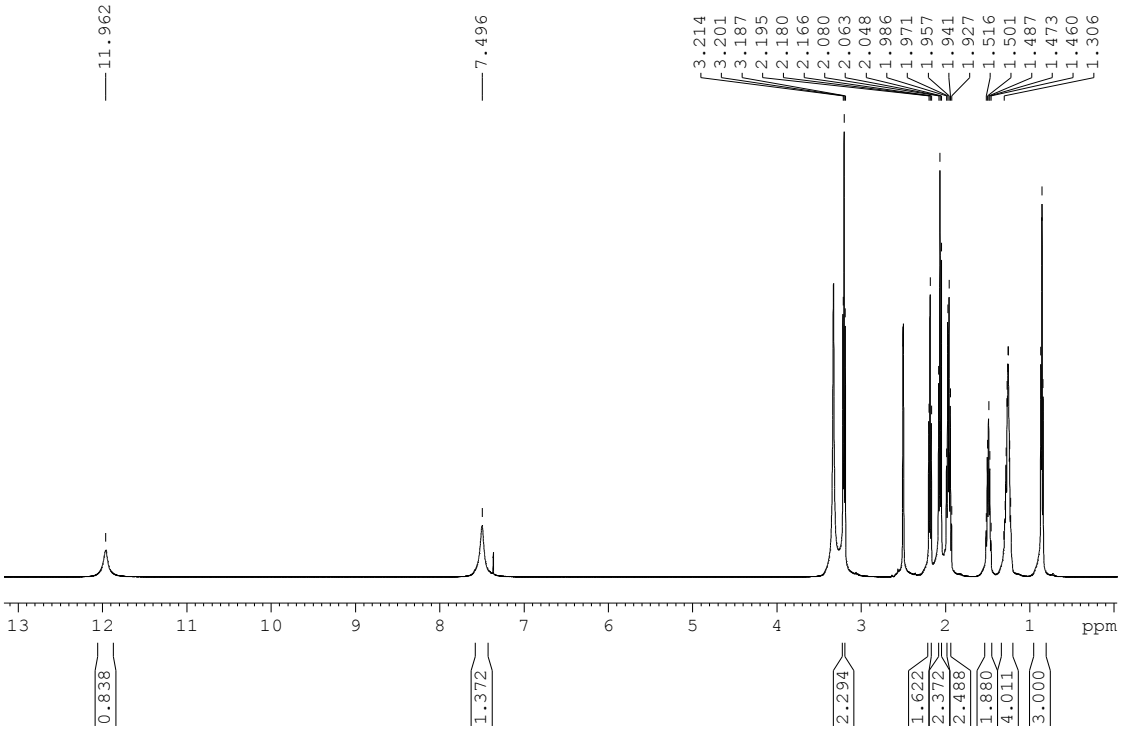


Figure S11: Butyrolactam hexanoate

Spectral data: ^{1}H NMR(DMSO-d_6): 0.75(m,3H), 1.30(m,4H), 1.50(m,2H), 1.92(m,2H), 2.05(m,2H), 2.19(m,2H), 3.20(m,2H), 7.49(b,1H), 11.96(b,1H).

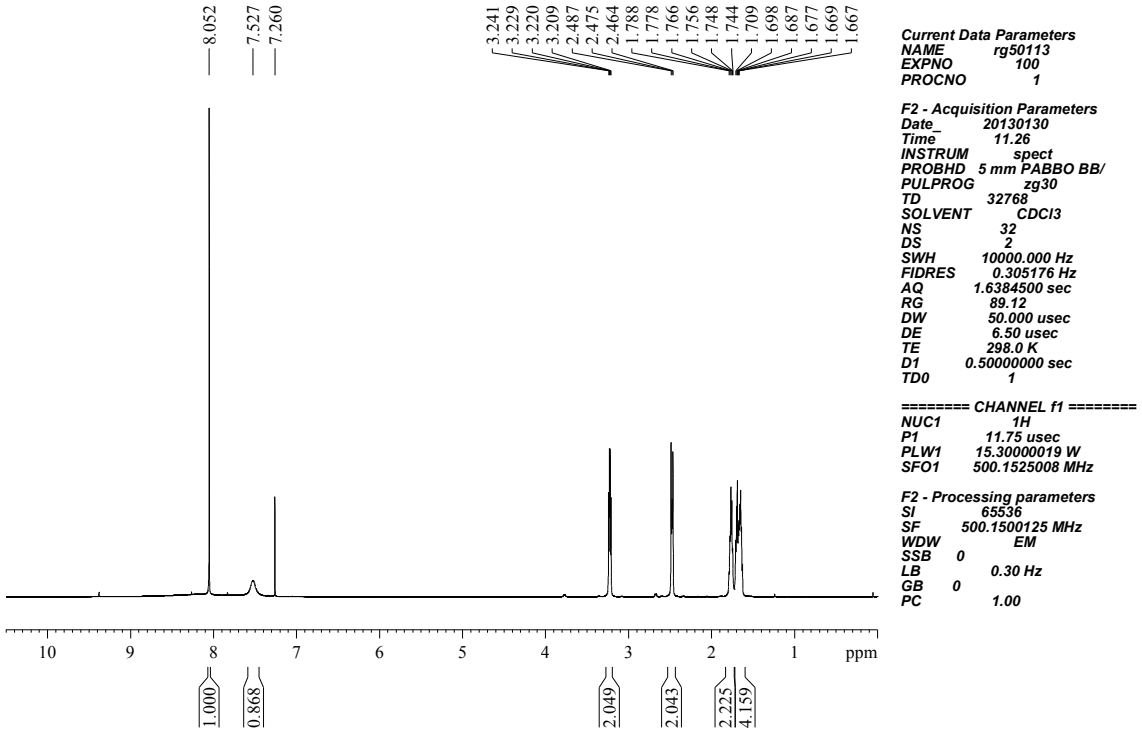


Figure S12: Caprolactam formate

Spectral data: ^{1}H NMR($CDCl_3$-d): 1.65(m,4H), 1.75(m,2H), 2.47(m,2H), 3.22(m,2H), 7.52(b,1H), 8.05(s,1H).

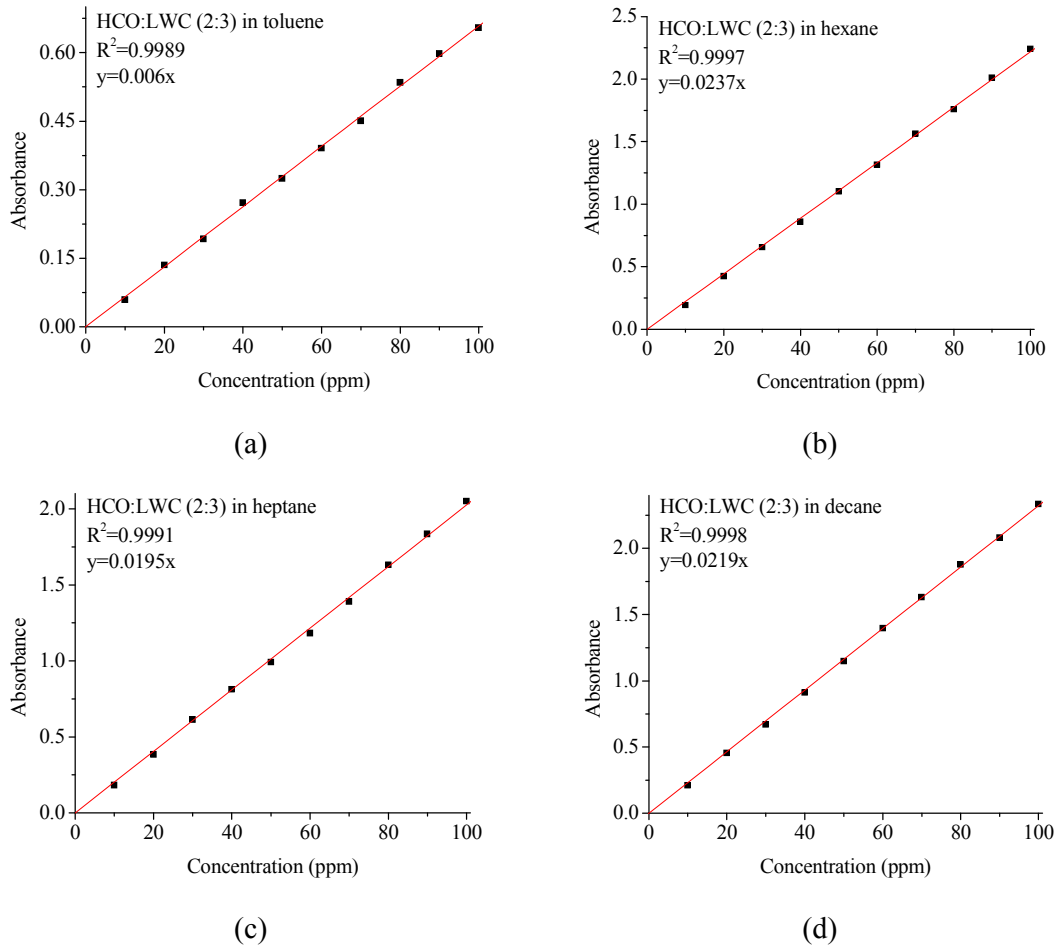


Figure S13: Standard calibration curve (Linear fit) – UV absorption for the HCO:LWC (2:3 wt/wt) in different solvents such as (a) toluene, (b) hexane, (c) heptane, (d) decane at different concentrations (ppm).

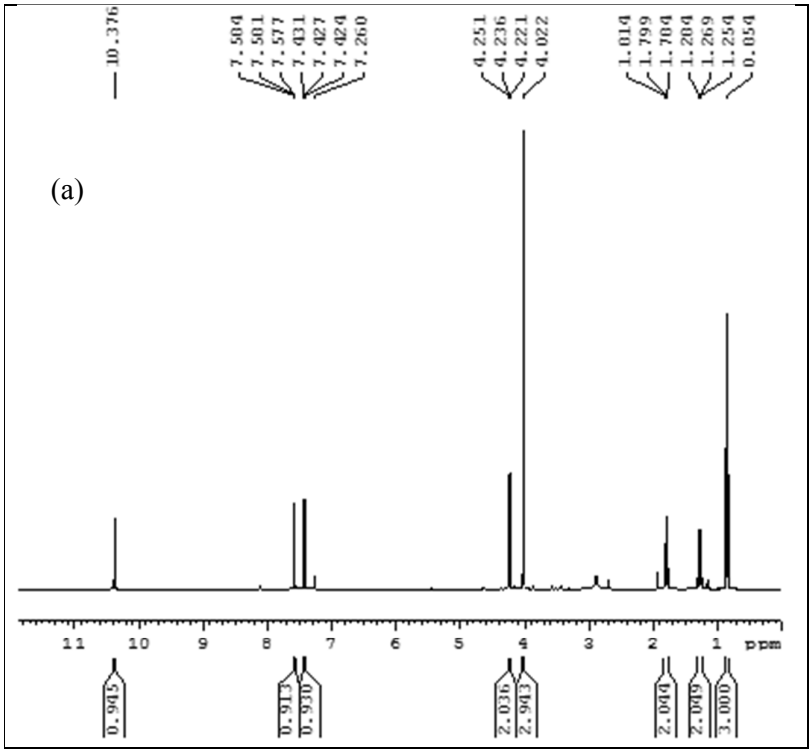
Test for the reusability of IL:

500 mL system was considered, i.e., 500 mg HCO:LWC (2:3 wt/wt) + 50 mg $[C_4mim]^+[Cl^-]$ was taken in 500 mL standard measuring flask and filled till the mark with heptane.

From the above solution, the dissolved portion was decanted and the rest of the undissolved portion was mixed with **4-6 mL of water** and the liquefied portion was separated and taken in the rota vapour to remove the water at the temperature of **358.15 K**, followed by **24 hrs vacuum** application. After all these processes, the remaining liquid (viscous liquid) was quantified to be **45.5 mg**. This sample was further subjected to ^{1}H-NMR and **water content (2705 ppm)** analysis and compared with pure $[C_4mim]^+[Cl^-]$ (see Table 1). The ^{1}H-NMR spectra of the fresh $[C_4mim]^+[Cl^-]$ and processed/reused $[C_4mim]^+[Cl^-]$ are compared in the Figure S14, and there was no considerable variation in the peaks observed on their comparison. From this recovered IL, 10 mg of IL was re-used with the 100 mg of HCO:LWC (2:3 wt/wt) and the increase in solubility was observed. The increase in solubility for fresh

$[C_4mim]^+[Cl^-]$ was 33.61 % at 70 ppm of HCO:LWC (2:3 wt/wt) and for the second trial (re-usage of the recovered IL, $[C_4mim]^+[Cl^-]$) it was found to be 28.95 %. Alternatively, undissolved solid portion (after water wash) was dried thoroughly in the oven at 358.15 K followed by vacuum for about 3-4 hrs and was quantified to be 41 mg later. From this 41mg, 35 mg was used for ^{13}C-NMR, 2 mg was used for IR study. Similarly, for the system of HCO:LWC (2:3 wt/wt)+heptane, the undissolved portion was found to be 62 mg. From this 62 mg, 35 mg was used for ^{13}C-NMR and 2 mg was used for IR.

Sample/solvent quantities for the FT-IR/^{13}C-NMR experimental studies are:
sample weight= 35 mg for ^{13} C-NMR, $CDCl_3$=0.7 mL, sample weight for IR= 2 mg, weight of KBr= 70 mg.



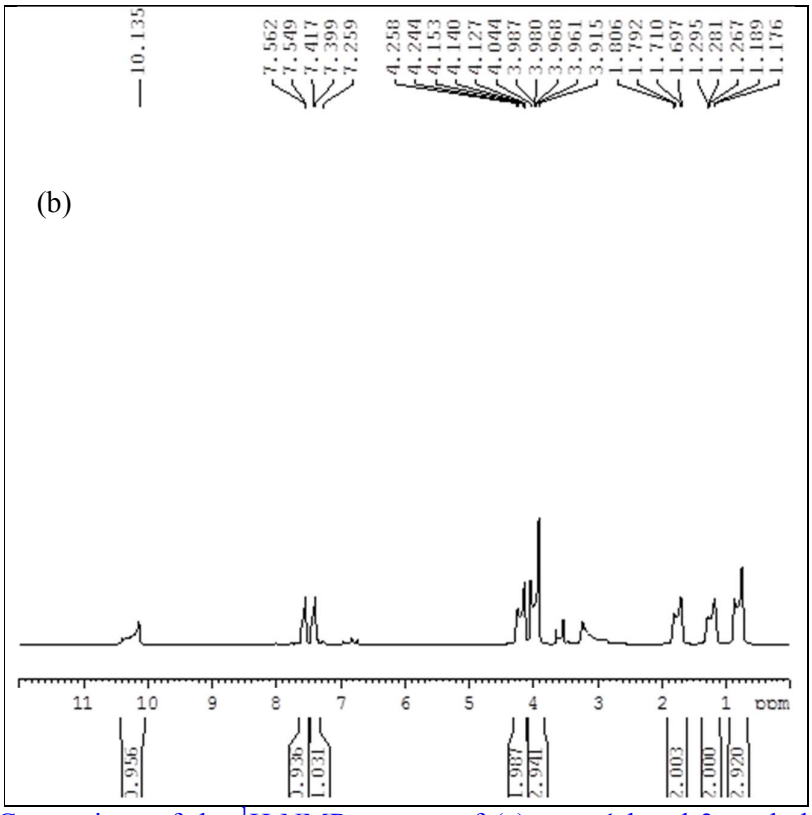
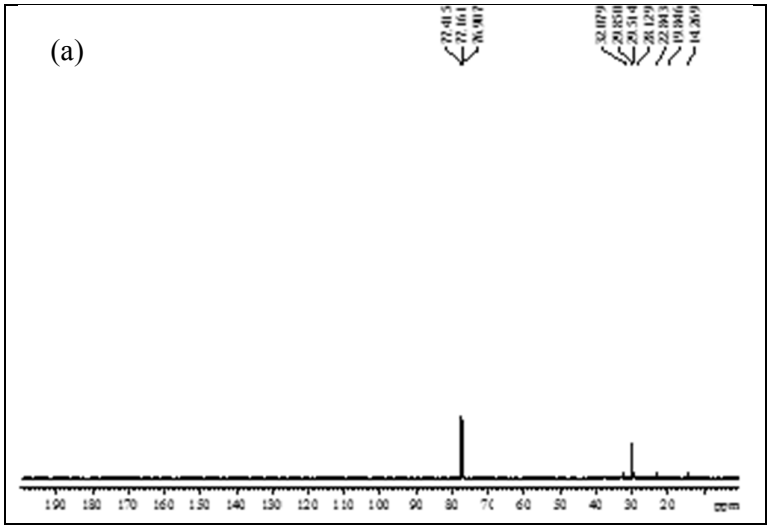


Figure S14: Comparison of the ^{1}H-NMR spectra of (a) pure 1-butyl-3-methyl imidazolium chloride and (b) processed/reused 1-butyl-3-methyl imidazolium chloride.

The ionic liquids which were used here are 100 % water soluble. When we recorded the ^{13}C-NMR spectra for the left over sample, there were no other peaks observed corresponding to the ionic liquid $[CP]^{+}[HCOO]^{-}$. Simple comparison of the ^{13}C-NMR spectra of pure IL, $[CP]^{+}[HCOO]^{-}$ with the ^{13}C-NMR spectra of solvent+IL (heptane+$[CP]^{+}[HCOO]^{-}$) treated undissolved residue of HCO:LWC (in 2:3 wt/wt) are compared in Figure S15 and proved the absence of IL in the residual portion after water wash.



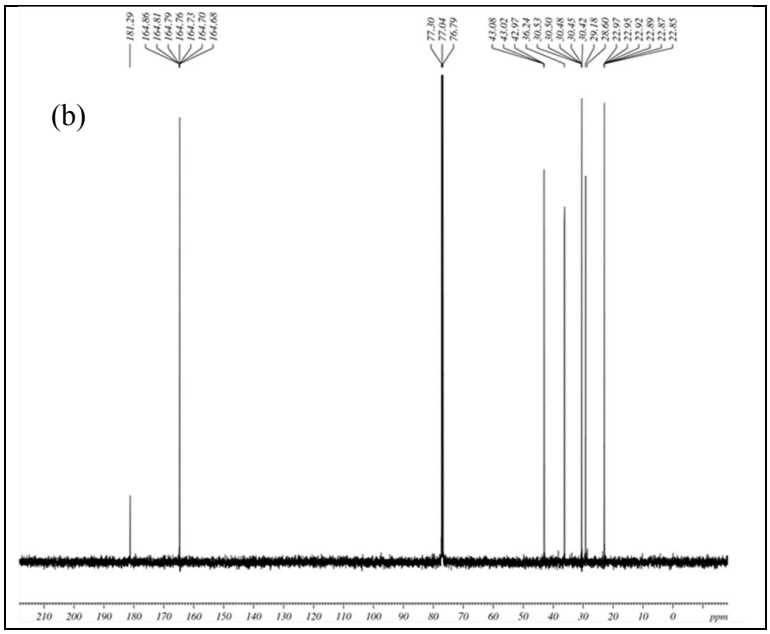


Figure S15: 13C-NMR spectra of (a) HCO:LWC (in 2:3 wt/wt)+heptane+$[CP]^{+}[HCOO]^{-}$ (residue HCO), (b) pure IL, $[CP]^{+}[HCOO]^{-}$.

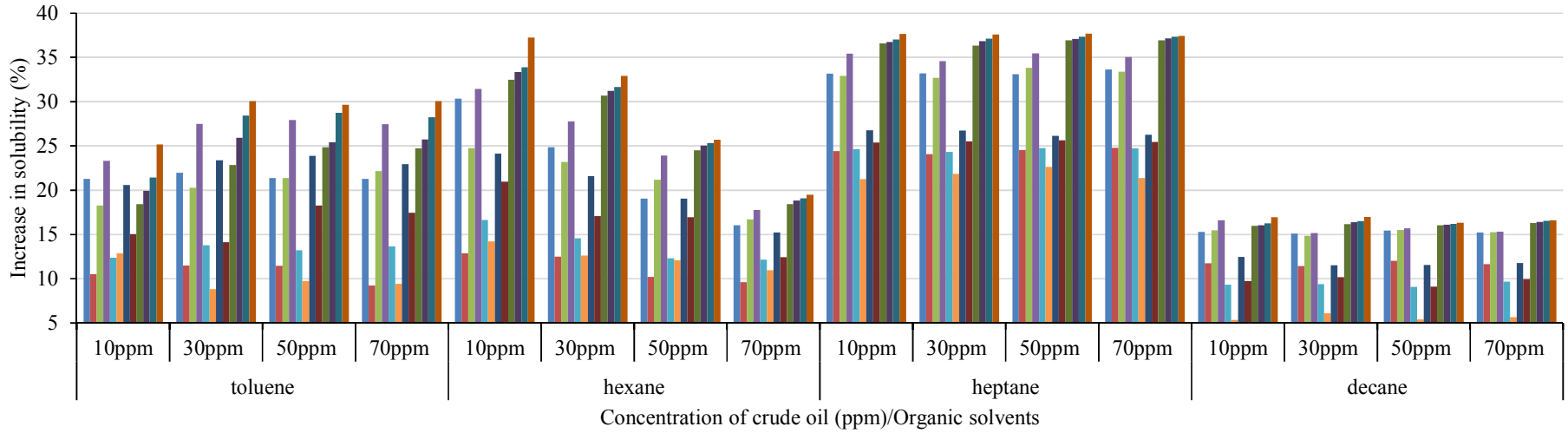


Figure S16: Comparison of the efficiency of the ILs in terms of increase in solubility of HCO:LWC (2:3 wt/wt) in all the mentioned solvents involved in the present investigation at four different concentrations of HCO+LWC solutions. Base line of 0 % solubility is for standard solution. ■ $[BMIM]^+[Cl]^-$; ■ $[BMIM]^+[Br]^-$; ■ $[BMIM]^+[HSO_4]^-$; ■ $[OMIM]^+[Cl]^-$; ■ $[Et_3NH]^+[HSO_4]^-$; ■ $[Et_3NH]^+[H_2PO_4]^-$; ■ $[Et_3NH]^+[CH_3COO]^-$; ■ $[Pr_3NH]^+[HSO_4]^-$; ■ $[BT]^+[HCOO]^-$; ■ $[BT]^+[CH_3COO]^-$; ■ $[BT]^+[C_6H_{13}COO]^-$; ■ $[CP]^+[HCOO]^-$. Here the ILs is used in 100 ppm concentration.