Supporting Information: Free energy calculations and solubility in water of organic molecules: a numerical relation through Molecular Dynamics

ARTICLE HISTORY
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On this section, tables with the names of the molecules and properties obtained are reported.

Table 1. ΔG_{hyd}, ΔG_{solv} and Δ^s in kJ/mol for LigParGen molecules soluble in water. The uncertainties on these properties are ± 0.37, ± 0.81 and ± 1.19 kJ/mol respectively.

molecule	ΔG_{hyd} (kJ/mol)	ΔG_{solv} (kJ/mol)	Δ^s (kJ/mol)
methanoic acid	-27.58	-30.07	-2.49
2-aminoethanol	-36.22	-30.71	5.51
propan-1-amine	-16.19	-13.67	2.52
propan-2-one	-15.57	-19.3	-3.73
methanal	-12.61	-18.25	-5.64
methylamine	-15.56	-12.02	3.54
ethylamine	-16.22	-12.58	3.64
propan-1-amine	-16.19	-13.67	2.52
butylamine	-14.93	-18.05	-3.12
dimethylether	-6.62	-10.37	-3.75
formic acid	-28.4	-30.09	-1.69
ethanoic acid	-40.65	-43.22	-2.57
methanol	-20.34	-18.76	1.58
ethanol	-21.11	-18.39	2.72
propanol	-20.52	-19.47	1.05
butanol	-19.51	-21.42	-1.91
2-butanol	-20.3	-21.37	-1.07
1-2-dimethoxyetane	-25.63	-20.83	4.80
acetaldehyde	-14.27	-17.66	-3.39
oxolane	-12.4	-17.17	-4.77
3-pentanol	-19.2	-21.58	-2.38
n-ethyl ethanamine	-19.62	-17.00	2.62
pyrrolidone	-16.53	-19.05	-2.52
methanediol	-29.36	-28.47	0.89
ethanediol	-41.95	-40.24	1.71
propanediol	-45.51	-43.37	2.14
butanediol	-49.1	-41.99	7.11
pentanediol	-49.06	-46.79	2.27
hexanediol	-48.68	-45.93	2.75

Table 2. ΔG_{hyd}, ΔG_{solv} and Δ^s in kJ/mol for LigParGen molecules partially soluble in water. The uncertainties on these properties are ± 0.37, ± 0.81 and ± 1.19 kJ/mol respectively.

molecule	ΔG_{hyd} (kJ/mol)	ΔG_{solv} (kJ/mol)	Δ^s (kJ/mol)
methyl formate	-14.14	-21.18	-7.04
acetonitrile	-14.22	-19.83	-5.61
methoxymethane	-6.81	-13.17	-6.36
acetyl acetate	-27.33	-38.38	-11.05
nitromethane	-14.72	-24.13	-9.41
penthylamine	-14.25	-18.45	-4.20
methyl-ethylether	-8.11	-12.32	-4.21
methylpropylether	-6.70	-14.86	-8.16
butanoic acid	-37.04	-42.91	-5.87
pentanoic acid	-34.69	-44.03	-9.34
pentanol	-18.65	-25.02	-6.37
methanethiol	-9.09	-17.70	-8.61
propanoic acid	-37.47	-42.59	-5.12
phenol	-28.04	-40.16	-12.12
2-methylpyridine	-22.45	-32.59	-10.14
2-pentanone	-15.03	-19.51	-4.48
dimethylsulfide	-7.13	-17.91	-10.78
methylacetate	-14.46	-21.11	-6.65
methylacrylate	-13.85	-24.61	-10.76
ethanamide	-43.94	-53.82	-9.88
cyclohexanone	-17.11	-27.63	-10.52
phenilmethanol	-28.39	-36.38	-7.99
nitromethane	-14.87	-25.58	-10.71
pyridine	-18.92	-27.71	-9.71

Table 3. ΔG_{hyd}, ΔG_{solv} and Δ^s in kJ/mol for LigParGen molecules insoluble in water. The uncertainties on these properties are ± 0.37, ± 0.81 and ± 1.19 kJ/mol respectively.

molecule	ΔG_{hyd} (kJ/mol)	ΔG_{solv} (kJ/mol)	Δ^s (kJ/mol)
chloroethane	-3.44	-15.91	-12.47
1,1-dichloroethane	-6.37	-21.82	-15.45
chloroform	-5.43	-20.41	-14.98
thiophene	-6.04	-21.55	-15.51
1,1-dichloroethene	3.49	-15.41	-18.90
hexylamine	-13.94	-21.47	-7.53
methyl-butylether	-6.17	-17.37	-11.20
hexanoic acid	-34.95	-47.17	-12.22
hexanol	-18.28	-27.47	-9.19
ethanethiol	-9.04	-19.31	-10.27
propanethiol	-8.64	-21.37	-12.73
buthanethiol	-7.08	-23.54	-16.46
nitrobenzene	-17.02	-45.4	-28.38
benzenethiol	-11.07	-33.86	-22.79
3-methylpyridine	-19.43	-32.73	-13.3
chloroaniline	-20.4	-45.92	-25.52
nitroethane	-14.14	-26.71	-12.57
nitropropane	-12.43	-27.74	-15.31
nitrobutane	-13.67	-30.29	-16.62
diethyldisulfide	-8.36	-30.43	-22.07
4-methylpiridine	-19.71	-33.89	-14.18
hexanone	-13.90	-24.81	-10.91
2-nitropropane	-13.26	-26.68	-13.42
thiolane	-11.31	-25.12	-13.81

Table 4. ΔG_{hyd}, ΔG_{solv}, Δ^s in kJ/mol and solubility in water for ethanol, hexanol and pentane taken from TraPPE, CHARMM and GROMOS force fields. The uncertainties on the free energies are ± 0.37, ± 0.81 and ± 1.19 kJ/mol respectively.

	ΔG_{hyd}	ΔG_{solv}	Δ^s	S
TRAPPE				
ethanol	-19.04	-21.99	-2.95	soluble
hexanol	-14.60	-29.65	-15.05	insoluble
pentane	10.67	-13.26	-23.93	insoluble
CHARMM				
ethanol	-20.06	-23.23	-3.17	soluble
hexanol	-16.76	-82.61	-65.85	insoluble
pentane	12.32	-15.64	-27.86	insoluble
GROMOS				
ethanol	-29.39	-30.12	-0.73	soluble
hexanol	-32.21	-43.16	-10.95	insoluble
pentane	9.53	-13.95	-23.48	insoluble

Table 5. Solubilities from Molecular Dynamics calculations and experimental. The average uncertainty on these simulation results is ± 5.05 kg/m^3.

OPLS/LigParGen	S(g/L) MD	S(g/L) exp	reference/T(K)
ciclohexanone	14.22	25	[1]/298.15
3-pentanol	520.20	10	[2]/303.15
morpholine	1000.00	1000	[3]/293.15
n-ethyletanamine	1000.00	1000	[4]/293.15
pyridine	34.53	1000	[5]/298.15
pyrrolidone	1000.00	1000	[4]/293.15
thiolane	4.98	0	[6]/293.15
metanediol	1000.00	15	[7]/298.15
etanediol	1000.00	1000	[4]/293.15
propanediol	1000.00	1000	[1]/298.15
butanediol	1000.00	1000	[4]/293.15
pentanediol	1000.00	1000	[8]/293.15
hexanediol	1000.00	1000	[3]/293.15
phenol	33.80	66.6	[3]/293.15
2-methylpyridine	63.12	1000	[9]/298.15
nitrobenzene	0	2.09	[10]/298.15
benzenethiol	0.32	0.835	[11]/298.15
3-methylpyridine	8.49	1000	[9]/298.15
4-methylpyridine	22.13	1000	[9]/298.15
2-chloroaniline	14.80	8.165	[12]/298.15
nitromethane	35.81	111	[13]/293.15
nitroethane	6.89	48	[13]/293.15
1-nitropropane	4.53	15-14	[13]/293.15
2-nitropropane	1.95	17	[5]/298.15
2-propanone	575.56	1000	[3]/293.15
2-butanone	29.87	211-223	[13]/293.15
2-pentanone	29.36	43	[1]/298.15
2-hexanone	6.95	17.2	[13]/293.15
GROMOS			
hexanol	15.55	5.9	[13]/293.15
ethanol	1000.00	1000	[3]/293.15
pentane	0.00	0.38	[4]/293.15
CHARMM			
hexanol	0.97	5.9	[13]/293.15
ethanol	1000.00	1000	[3]/293.15
pentane	0.00	0.38	[4]/293.15

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