Activity Coefficients at Infinite Dilution of Organic Solutes and Water in Tributylethylphosphonium Diethylphosphate Using Gas − Liquid Chromatography. Thermodynamic Properties of Mixtures Containing Ionic Liquids.

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Table 1S. The sources and mass fraction purities of materials used.[a]

Chemical name[a]	Source	Initial mass fraction purity	Purification method	Final mass fraction purity	Analysis method
$[P_{2,4,4,4}][DEP]$	Iolitec	0.95	373 K, Vacuum Drying Ovens, 48h	-	-
Pentane	Fluka	≥ 0.99	–	–	–
Hexane	Fluka	≥ 0.99	–	–	–
3-Methylpentane	Aldrich	≥ 0.99	–	–	–
2,2-Dimethylbutane	Aldrich	≥ 0.99	–	–	–
Heptane	Aldrich	≥ 0.995	–	–	–
Octane	Aldrich	≥ 0.99	–	–	–
2,2,4-Trimethylpentane	Aldrich	≥ 0.99	–	–	–
Nonane	Aldrich	≥ 0.99	–	–	–
Decane	Aldrich	≥ 0.99	–	–	–
Cyclopentane	Aldrich	≥ 0.99	–	–	–
Cyclohexane	Aldrich	≥ 0.99	–	–	–
Methylcyclohexane	Aldrich	≥ 0.99	–	–	–
Cycloheptane	Aldrich	≥ 0.98	–	–	–
Cyclooctane	Fluka	≥ 0.99	–	–	–
Pent-1-ene	Acros	≥ 0.985	–	–	–
Hex-1-ene	Aldrich	≥ 0.99	–	–	–
Cyclohexene	Aldrich	≥ 0.99	–	–	–
Hept-1-ene	Aldrich	≥ 0.99	–	–	–
Oct-1-ene	Aldrich	≥ 0.98	–	–	–
Dec-1-ene	Aldrich	≥ 0.97	–	–	–
Pen-1-yne	Aldrich	≥ 0.97			
Hex-1-yne	Aldrich	≥ 0.97	–	–	–
Hept-1-yne	Aldrich	≥ 0.98	–	–	–
Oct-1-yne	Aldrich	≥ 0.97	–	–	–
Benzene	Aldrich	≥ 0.998	–	–	–
Toluene	Aldrich	≥ 0.998	–	–	–
Ethylbenzene	Aldrich	≥ 0.998	–	–	–
o-Xylene	Aldrich	≥ 0.99	–	–	–
m-Xylene	Aldrich	≥ 0.99	–	–	–
p-Xylene	Aldrich	≥ 0.99	–	–	–
Styrene	Aldrich	≥ 0.999	–	–	–
Methanol	Aldrich	≥ 0.999	–	–	–
Ethanol	Aldrich	≥ 0.998	–	–	–
Water	own source	–	distillation, filtration	≥ 0.999	density
Thiophene	Aldrich	≥ 0.99	–	–	–
Oxolane (Tetrahydrofurane, THF)	Aldrich	≥ 0.999	–	–	–
1,4-Dioxane	Aldrich	≥ 0.998	–	–	–
2-Methoxy-2-	Aldrich	≥ 0.998	–	–	–

Chemical name[a]	Source	Initial mass fraction purity	Purification method	Final mass fraction purity	Analysis method
methylpropane (*tert*-Butyl methyl ether)					
2-Methoxy-2-methylbutane (Methyl *tert*-pentyl ether)	Aldrich	≥ 0.99	–	–	–
2-Ethoxy-2-methylpropane (Ethyl *tert*-butyl ether)	Aldrich	≥ 0.99	–	–	–
Ethoxyethane (Diethyl ether)	Aldrich	≥ 0.999	–	–	–
1-Propoxypropane (Di-*n*-propyl ether)	Aldrich	≥ 0.99	–	–	–
2-Propan-2-yloxypropane (Di-*iso*-propyl ether)	Fluka	≥ 0.99	–	–	–
1-Butoxybutane (Di-*n*-butyl ether)	Aldrich	≥ 0.993	–	–	–
Propan-2-one (Acetone)	Aldrich	≥ 0.999	–	–	–
Pentan-2-one	Aldrich	≥ 0.99	–	–	–
Pentan-3-one	Aldrich	≥ 0.99	–	–	–
Hexan-2-one	Aldrich	≥ 0.99	–	–	–
Hexan-3-one	Aldrich	≥ 0.99	–	–	–
Acetonitrile	Fluka	≥ 0.999	–	–	–
Pyridine	Aldrich	≥ 0.998	–	–	–
1-Nitropropane	Aldrich	≥ 0.985	–	–	–

[a] Names in parentheses are common names used in the text.

Table 2S. Mean column pressure, $\bar{p}$, inlet column pressure, p_i, outlet column pressure, p_o and standard state of solutes at given temperatures, st. state[a]

solute		T / K				
		328.15	338.15	348.15	358.15	368.15
pentane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
hexane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
3-methylpentane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
2,2-dimethylbutane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
heptane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
octane	$\bar{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid

2,2,4-trimethylpentane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
nonane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
decane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
cyclopentane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
cyclohexane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
methylcyclohexane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
cycloheptane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical	hypothetical	hypothetical	hypothetical	hypothetical

		liquid	liquid	liquid	liquid	liquid
cyclooctane	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-pentene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-hexene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
cyclohexene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-heptene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-octene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-decene	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical	hypothetical	hypothetical	hypothetical	hypothetical

		liquid	liquid	liquid	liquid	liquid
1-pentyne	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-hexyne	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-heptyne	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-octyne	$\overline{p}$ /kPa	112.5	112.7	109.7	110.5	110.5
	pi /kPa	122.2	120.2	119.4	120.2	120.2
	po /kPa	102.2	100.2	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
benzene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
toluene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
ethylbenzene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical	hypothetical	hypothetical	hypothetical	hypothetical

		liquid	liquid	liquid	liquid	liquid
o-xylene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
m-xylene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
p-xylene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
styrene	$\overline{p}$ /kPa	133.1	132.3	132.3	133.7	133.7
	pi /kPa	168.8	160.0	160.0	161.4	161.4
	po /kPa	100.8	100.0	100.0	101.4	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
methanol	$\overline{p}$ /kPa		133.0	132.3	132.3	133.7
	pi /kPa		167.7	160.0	160.0	161.4
	po /kPa		100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
ethanol	$\overline{p}$ /kPa		133.0	132.3	132.3	133.7
	pi /kPa		160.7	160.0	160.0	161.4
	po /kPa		100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
water	$\overline{p}$ /kPa	133.1	132.3	132.3	132.3	132.3
	pi /kPa	160.8	160.0	160.0	160.0	160.0
	po /kPa	100.8	100.0	100.0	100.0	100.0
	st. state	hypothetical	hypothetical	hypothetical	hypothetical	hypothetical

		liquid	liquid	liquid	liquid	liquid
thiophene	$\overline{p}$ /kPa	133.1	132.3	132.3	132.3	133.7
	pi /kPa	160.8	160.0	160.0	160.0	161.4
	po /kPa	100.8	100.0	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
tetrahydrofuran	$\overline{p}$ /kPa	133.1	133.0	132.3	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1,4-dioxane	$\overline{p}$ /kPa	133.1	133.0	132.3	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
methyl *tert*-butyl ether	$\overline{p}$ /kPa	112.5	112.1	109.7	110.5	110.5
	pi /kPa	122.2	121.8	119.4	120.2	120.2
	po /kPa	102.2	101.8	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
ethyl *tert*-butyl ether	$\overline{p}$ /kPa	112.3	112.4	109.7	110.5	110.5
	pi /kPa	122.0	121.8	119.4	120.2	120.2
	po /kPa	102.0	101.8	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
methyl *tert*-pentyl ether	$\overline{p}$ /kPa	112.3	112.1	109.7	110.5	110.5
	pi /kPa	122.0	121.8	119.4	120.2	120.2
	po /kPa	102.0	101.8	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
diethyl ether	$\overline{p}$ /kPa	112.5	112.1	109.7	110.5	110.5
	pi /kPa	122.2	121.8	119.4	120.2	120.2

	po /kPa	102.2	101.8	99.4	100.2	100.2
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
di-*n*-propyl ether	$\overline{p}$ /kPa	110.7	111.1	111.1	111.2	111.2
	pi /kPa	120.4	120.8	120.8	120.9	120.9
	po /kPa	100.4	100.8	100.8	100.9	100.9
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
di-*iso*-propyl ether	$\overline{p}$ /kPa	110.7	111.1	111.1	111.0	111.2
	pi /kPa	120.4	120.8	120.8	120.7	120.9
	po /kPa	100.4	100.8	100.8	100.7	100.9
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
di-*n*-butyl ether	$\overline{p}$ /kPa	110.7	111.1	111.1	111.0	111.2
	pi /kPa	120.4	120.8	120.8	120.7	120.9
	po /kPa	100.4	100.8	100.8	100.7	100.9
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
acetone	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
2-pentanone	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
3-pentanone	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
2-haxanone	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4

	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
3-hexanone	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
acetonitrile	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
pyridine	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid
1-nitropropane	$\overline{p}$ /kPa	133.1	133.0	132.2	132.3	133.7
	pi /kPa	160.8	160.7	160.0	160.0	161.4
	po /kPa	100.8	100.7	100.0	100.0	101.4
	st. state	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid	hypothetical liquid

[a] Standard uncertainties u are $u(T) = 0.02$ K, $u(\overline{p}) = 0.06$ kPa, $u(p_i) = 0.1$ kPa, $u(p_o) = 0.07$ kPa

Figure 1S. DSC diagram for pure $[P_{2444}][DEP]$