Section 3

Glycol ethers

Propylene glycol methyl ether

Alternative names
1-Methoxy-2-propanol, PM, PGME

Reference codes

CAS number	107 98 2	Hazchem code	
UN number		EPA code	

Physical properties

Molecular weight	90	Cubic expansion coeff (per °C × 10^3)	1.03
Empirical formula	$C_4H_{10}O_2$	Surface tension (@20°C dyn/cm)	27.0
Boiling point (°C)	121	Absolute viscosity (@25°C cP)	1.9
Freezing point (°C)	–139	Refractive index (25°C)	1.407
Specific gravity (20/4)	0.924		

Fire hazards

Flash point (closed cup °C)	32	Lower explosive limit (ppm)	
Autoignition temperature (°C)	290	Upper explosive limit (ppm)	
Electrical conductivity	4.5E–7		

Health hazards

IDLH (ppm)		Vapour concentration @21°C ppm	11000
OES-TWA	100	Vapour density (relative to air)	3.1
OES-STEL	300	Vapour pressure @21°C mmHg	8.3
Odour threshold (ppm)		POCP	80

Aqueous effluent

Solubility in water (25°C %w/w)		Total
Solubility of water in (25°C %w/w)		Total
Log_{10} activated carbon partition		
Log_{10} partition in octanol/water (w/w)		
Biological oxygen demand w/w (days)		0.16 (5)
Theoretical oxygen demand w/w		1.95

Vapour pressure equation constants (Log_{10}, mmHg)

Antoine equation	A
	B
	C
Cox chart	A
	B

Solvent properties

Solubility parameter	14.3	Kauri butanol value	
Dipole (D)	1.67	Evaporation time (ether = 1)	22
Dielectric constant (20°C)		Evaporation time (BuAc = 1)	0.66
Polarity (water 100)			

Thermal information

Latent heat (cal/mol)	9180
Nett heat of combustion (kcal/gmol)	682
Specific heat (cal/mol/°C)	49.5
Critical pressure (MN/m^2)	
Critical temperature (K)	552
Latent heat of fusion (cal/mol)	
Van der Waals' volume	
Van der Waals' surface area	
Molar volume	97.4

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Hydrocarbons							
n-Pentane							
n-Hexane							
n-Heptane							
n-Octane							
n-Nonane							
n-Decane							
2,2,4-TMP							
Cyclohexane							
Benzene							
Toluene	30	107	8512				
Ethylbenzene							
Xylenes							
C_9 Aromatics							
Tetralin							
Alcohols							
Methanol							
Ethanol							
n-Propanol							
i-Propanol							
n-Butanol							
i-Butanol							
s-Butanol							
n-Amyl alc.							
i-Amyl alc.							
Cyclohexanol							
1-Octanol							
Ethanediol							
DEG							
1,2-Propanediol	None		6650a				
Glycol ethers							
PGME	–		–	–	–	–	–
EGME							
EEE							
EGBE							
Chlorinated							
MDC							
Chloroform							
Carbon tet.							
1,2-EDC							
1,1,1-TCA							
TCE							
Perk.							
MCB							

Solute	Azeotrope			Solute γ^{∞}	Reference	Partition coefficient	Reference
	X% w/w	°C	Reference				
Ketones							
Acetone							
MEK							
MIBK							
Cyclohexanone							
NMP							
Acetophenone							
Ethers							
Diethyl ether							
DIPE							
Dibutyl ether							
MTBE							
1,4-Dioxane							
THF							
Esters							
Me acetate							
Et acetate							
i-Propyl acetate							
n-Butyl acetate							
Cellosolve acetate							
Miscellaneous							
DMF							
DMAc							
DMSO							
Sulfolane							
CS_2							
Acetic acid							
Aniline							
Nitrobenzene							
Morpholine							
Pyridine							
2-Nitropropane							
Acetonitrile							
Furfuraldehyde							
Phenol							
Water	65	97	384				

Ethylene glycol methyl ether

Alternative names
Methyl cellosolve, EGME, 2-methoxyethanol, ME, methyl glycol

Reference codes			
CAS number	109 86 4	Hazchem code	2(S)
UN number	1188	EPA code	
Physical properties			
Molecular weight	76	Cubic expansion coeff (per °C × 10^3)	0.92
Empirical formula	$C_3H_8O_2$	Surface tension (@20°C dyn/cm)	33.0
Boiling point (°C)	125	Absolute viscosity (@25°C cP)	1.6
Freezing point (°C)	–85	Refractive index (25°C)	1.400
Specific gravity (20/4)	0.966		
Fire hazards			
Flash point (closed cup °C)	38	Lower explosive limit (ppm)	25000
Autoignition temperature (°C)	288	Upper explosive limit (ppm)	198000
Electrical conductivity	1.0E–6		
Health hazards			
IDLH (ppm)	2000	Vapour concentration @21°C ppm	9300
OES-TWA	5	Vapour density (relative to air)	2.6
OES-STEL		Vapour pressure @21°C mmHg	7
Odour threshold (ppm)	90	POCP	
Aqueous effluent			
Solubility in water (25°C %w/w)		Total	
Solubility of water in (25°C %w/w)		Total	
Log_{10} activated carbon partition		1.50	
Log_{10} partition in octanol/water (w/w)		–0.77	
Biological oxygen demand w/w (days)		0.50 (5)	
Theoretical oxygen demand w/w		1.68	
Vapour pressure equation constants (Log_{10}, mmHg)			
Antoine equation	A	7.8498	
	B	1793.982	
	C	236.877	
Cox chart	A		
	B		
Solvent properties			
Solubility parameter	10.8	Kauri butanol value	
Dipole (D)	2.0	Evaporation time (ether = 1)	34
Dielectric constant (20°C)	16.9	Evaporation time (BuAc = 1)	0.47
Polarity (water 100)	66.7		
Thermal information			
Latent heat (cal/mol)	9424		
Nett heat of combustion (kcal/gmol)	399		
Specific heat (cal/mol/°C)	43		
Critical pressure (MN/m^2)	5.1		
Critical temperature (K)	565		
Latent heat of fusion (cal/mol)			
Van der Waals' volume			
Van der Waals' surface area			
Molar volume	78.7		

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Hydrocarbons							
n-Pentane							
n-Hexane				13.1	1x/3/1012		
n-Heptane	23	93	6592	4.4	1x/1/67		
n-Octane	48	110	6614	28.4	1x/3/1012		
n-Nonane							
n-Decane	92	123	6628				
2,2,4-TMP							
Cyclohexane	15	78	6572	5.7	2b/128		
Benzene	None		6567	2.3	2b/127		
Toluene	25	106	6586	3.6	1x/3/1012		
Ethylbenzene	51	117	6596	2.9	2b/132		
Xylenes	55	120	6598	3.1	2b/134		
C_9 Aromatics				3.8	2d/131		
Tetralin							
Alcohols							
Methanol	None		1979				
Ethanol	None		3982	1.1	1x/3/1012		
n-Propanol							
i-Propanol				1.7	2c/490		
n-Butanol	None		6546				
i-Butanol	None		6548				
s-Butanol	None		6547				
n-Amyl aAlc.	None		6560				
i-Amyl alc.	None		6562				
Cyclohexanol							
1-Octanol							
Ethanediol							
DEG							
1,2-Propanediol							
Glycol ethers							
PGME							
EGME	–		–	–	–	–	–
EEE							
EGBE							
Chlorinated							
MDC							
Chloroform							
Carbon tet.				3.1	2f/99		
1,2-EDC							
1,1,1-TCA							
TCE							
Perk.	24	109	2178				
MCB	47	119	6566	2.4	2d/120		

Solute	Azeotrope X w/w	Azeotrope °C	Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Ketones							
Acetone				1.6	2d/113		
MEK				2.0	2b/122		
MIBK	25	114	6575				
Cyclohexanone							
NMP							
Acetophenone							
Ethers							
Diethyl ether							
DIPE							
Dibutyl ether	68	122	6615				
MTBE							
1,4-Dioxane	None		6541	1.5	1x/3/1012		
THF							
Esters							
Me acetate							
Et acetate				1.7	2b/126		
i-Propyl acetate							
n-Butyl acetate	48	119	6576	2.4	2d/122		
Cellosolve acetate	None		6583				
Miscellaneous							
DMF							
DMAc							
DMSO							
Sulfolane				2.2	2f/103		
CS_2							
Acetic acid							
Aniline							
Nitrobenzene							
Morpholine							
Pyridine	None		6550				
2-Nitropropane							
Acetonitrile				1.7	2d/109		
Furfuraldehyde	None		6549				
Phenol	None		6568				
Water	19	99	294				

Ethylene glycol ethyl ether

Alternative names

Cellosolve, EGEE, 2-ethoxyethanol, EE, ethyl glycol

Reference codes			
CAS number	110 80 5	Hazchem code	2S
UN number	1711	EPA code	
Physical properties			
Molecular weight	90	Cubic expansion coeff (per °C × 10^3)	0.97
Empirical formula	$C_4H_{10}O_2$	Surface tension (@20°C dyn/cm)	28.2
Boiling point (°C)	135	Absolute viscosity (@25°C cP)	2.5
Freezing point (°C)	–70	Refractive index (25°C)	1.405
Specific gravity (20/4)	0.931		
Fire hazards			
Flash point (closed cup °C)	43	Lower explosive limit (ppm)	18000
Autoignition temperature (°C)	235	Upper explosive limit (ppm)	140000
Electrical conductivity	9.3E–8		
Health hazards			
IDLH (ppm)	6000	Vapour concentration @21°C ppm	5300
OES-TWA	5	Vapour density (relative to air)	3.1
OES-STEL		Vapour pressure @21°C mmHg	4
Odour threshold (ppm)	50	POCP	75
Aqueous effluent			
Solubility in water (25°C %w/w)		Total	
Solubility of water in(25°C %w/w)		Total	
Log_{10} activated carbon partition		1.95	
Log_{10} partition in octanol/water (w/w)		–0.54	
Biological oxygen demand w/w (days)		0.67 (5)	
Theoretical oxygen demand w/w		1.86	
Vapour pressure equation constants (Log_{10}, mmHg)			
Antoine equation	A	7.81910	
	B	1801.90	
	C	230	
Cox chart	A		
	B		
Solvent properties			
Solubility parameter	10.0	Kauri butanol value	
Dipole (D)	1.69	Evaporation time (ether = 1)	43
Dielectric constant (20°C)	5.3	Evaporation time (BuAc = 1)	0.32
Polarity (water 100)	62.7		
Thermal information			
Latent heat (cal/mol)	9540		
Nett heat of combustion (kcal/gmol)	503		
Specific heat (cal/mol/°C)	52		
Critical pressure (MN/m^2)			
Critical temperature (K)			
Latent heat of fusion (cal/mol)			
Van der Waals' volume	3.70		
Van der Waals' surface area	3.29		
Molar volume	97.41		

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Hydrocarbons							
n-Pentane							
n-Hexane	5	66	8442	6.0	2b/295		
n-Heptane	14	97	8461				
n-Octane	38	116	8478	5.5	2b/302		
n-Nonane	50	128	8493				
n-Decane							
2,2,4-TMP							
Cyclohexane							
Benzene	None		8425				
Toluene	11	109	8450	2.0	2f/337		
Ethylbenzene	43	126	8463	2.4	2d/299		
Xylenes	50	128	8465	2.9	2f/338		
C_9 Aromatics							
Tetralin							
Alcohols							
Methanol							
Ethanol	None		4032				
n-Propanol							
i-Propanol							
n-Butanol	None		8105				
i-Butanol	None		8306				
s-Butanol							
n-Amyl alc.	None		8419				
i-Amyl alc.	None		8420				
Cyclohexanol							
1-Octanol							
Ethanediol							
DEG							
1,2-Propanediol							
Glycol ethers							
PGME							
EGME							
EEE	–		–	–	–	–	–
EGBE							
Chlorinated							
MDC							
Chloroform							
Carbon tet.							
1,2-EDC							
1,1,1-TCA							
TCE							
Perk.	16	116	2190		2d/396		
MCB	32	127	8423				

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Ketones							
Acetone				1.0	2f/332		
MEK				1.6	2f/334		
MIBK	None		8433				
Cyclohexanone							
NMP							
Acetophenone							
Ethers							
Diethyl ether							
DIPE							
Dibutyl ether	50	127	8479				
MTBE							
1,4-Dioxane							
THF							
Esters							
Me acetate							
Et acetate	None		7571	1.5	2f/335		
i-Propyl acetate							
n-Butyl acetate	13	126	8434	1.6	2b/294		
Cellosolve acetate	None		8400				
Miscellaneous							
DMF							
DMAc							
DMSO							
Sulfolane							
CS_2							
Acetic acid							
Aniline							
Nitrobenzene							
Morpholine							
Pyridine	None		8407				
2-Nitropropane							
Acetonitrile	15	119	6279				
Furfuraldehyde	None		8406				
Phenol	None		8426				
Water	13	98	382	1.9	1/450		

Ethylene glycol monobutyl ether

Alternative names
Butyl glycol, butyl cellosolve, EB, 2-butoxyethanol, EGBE

Reference codes			
CAS number	111 76 2	Hazchem code	2R
UN number	2369	EPA code	
Physical properties			
Molecular weight	118	Cubic expansion coeff (per °C × 10^3)	0.92
Empirical formula	$C_6H_{14}O_2$	Surface tension (@20°C dyn/cm)	27.4
Boiling point (°C)	171	Absolute viscosity (@25°C cP)	6.4
Freezing point (°C)	–75	Refractive index (25°C)	1.417
Specific gravity (20/4)	0.902		
Fire hazards			
Flash point (closed cup °C)	68	Lower explosive limit (ppm)	11000
Autoignition temperature (°C)	214	Upper explosive limit (ppm)	106000
Electrical conductivity	4.3E–7		
Health hazards			
IDLH (ppm)	700	Vapour concentration @21°C ppm	922
OES-TWA	25	Vapour density (relative to air)	4.07
OES-STEL		Vapour pressure @21°C mmHg	0.7
Odour threshold (ppm)	0.5	POCP	75
Aqueous effluent			
Solubility in water (25°C %w/w)		Total | LCST 58°C	
Solubility of water in (25°C %w/w)		Total |	
Log_{10} activated carbon partition		2.40	
Log_{10} partition in octanol/water (w/w)		+0.83	
Biological oxygen demand w/w (days)		0.60 (5)	
Theoretical oxygen demand w/w		2.3	
Vapour pressure equation constants (Log_{10}, mmHg)			
Antoine equation	A	7.8448	
	B	1988.90	
	C	230.00	
Cox chart	A		
	B		
Solvent properties			
Solubility parameter	8.9	Kauri butanol value	
Dipole (D)	1.80	Evaporation time (ether = 1)	119
Dielectric constant (20°C)	5.3	Evaporation time (BuAc = 1)	0.06
Polarity (water 100)	60.2		
Thermal information			
Latent heat (cal/mol)	10266		
Nett heat of combustion (kcal/gmol)	778		
Specific heat (cal/mol/°C)	55		
Critical pressure (MN/m^2)	3.2		
Critical temperature (K)	641		
Latent heat of fusion (cal/mol)			
Van der Waals' volume	5.05		
Van der Waals' surface area	4.37		
Molar volume	131.84		

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Hydrocarbons							
n-Pentane							
n-Hexane							
n-Heptane							
n-Octane	None			3.3	2b/432		
n-Nonane							
n-Decane							
2,2,4-TMP							
Cyclohexane							
Benzene							
Toluene				1.3	2f/440		
Ethylbenzene	96	140					
Xylenes	None		12235				
C_9 Aromatics	30	160	12252				
Tetralin							
Alcohols							
Methanol							
Ethanol							
n-Propanol							
i-Propanol							
n-Butanol	None		8166	1.1	2f/89		
i-Butanol							
s-Butanol							
n-Amyl alc.							
i-Amyl alc.							
Cyclohexanol	None		11712				
1-Octanol							
Ethanediol							
DEG							
1,2-Propanediol							
Glycol ethers							
PGME							
EGME	–		–	–	–	–	–
EEE							
EGBE							
Chlorinated							
MDC							
Chloroform							
Carbon tet.							
1,2-EDC							
1,1,1-TCA							
TCE							
Perk.	None		2218				
MCB	None		10521				

Solute	Azeotrope X% w/w	Azeotrope °C	Azeotrope Reference	Solute γ^{∞}	Reference	Partition coefficient	Reference
Ketones							
Acetone							
MEK				1.4	2b/430		
MIBK							
Cyclohexanone							
NMP							
Acetophenone							
Ethers							
Diethyl ether							
DIPE							
Dibutyl ether	None		12247				
MTBE							
1,4-Dioxane							
THF							
Esters							
Me acetate							
Et acetate	None		7590				
i-Propyl acetate							
n-Butyl acetate	None		11823				
Cellosolve acetate	None		11989				
Miscellaneous							
DMF							
DMAc							
DMSO							
Sulfolane							
CS_2							
Acetic acid							
Aniline	None		11153				
Nitrobenzene	None		10710				
Morpholine							
Pyridine							
2-Nitropropane							
Acetonitrile							
Furfuraldehyde	12	161	8769				
Phenol	37	186	10904				
Water	21	99	584	0.73	1/526		