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Survey in Data of Solvents

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Review Article

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Abstract:
In this paper ., types of organic solvents , degree of polarity , type of polarity , solvation of compounds in various solvents ., melting points of some compounds , boiling points of solvents, preparation of solvents , choosing of solvent for reactions .

Keyword: liquid , choosing , proton.

Introduction:

Solvents can cause considerable confusion in reactions, because they're listed along with the reagents of a reaction but often don't actually participate in the reaction itself. A solvent is a **liquid** that serves as the medium for a reaction. It can serve two major purposes:

1. (Non-participatory) **to dissolve the reactants.** Remember "like dissolves like" ? Polar solvents are best for dissolving polar reactants (such as ions); nonpolar solvents are best for dissolving nonpolar reactants (such as hydrocarbons).
2. Participatory: as a source of **acid** (proton), **base** (removing protons), or as a **nucleophile**(donating a lone pair of electrons). The only class of solvents for which this is something you generally need to worry about are polar protic solvents (see below).

OK. So what does "polar" and "non-polar" mean?

Polar solvents have large dipole moments (aka "partial charges"); they contain bonds between atoms with very different electronegativities, such as oxygen and hydrogen.

Non polar solvents contain bonds between atoms with similar electronegativities, such as carbon and hydrogen (think hydrocarbons, such as gasoline). Bonds between atoms with similar electronegativities will lack partial charges; it's this absence of charge which makes these molecules "non-polar".

There are two common ways of measuring this polarity. One is through measuring a constant called "dielectric constant" or permitivity. The greater the dielectric constant, the greater the polarity (water = high, gasoline = low). A second comes from directly measuring the dipole moment.

There's a final distinction to be made and this causes confusion. Some solvents are called "protic" and some are called "aprotic". What makes a solvent a "protic" solvent, anyway?

- **Protic solvents** have O-H or N-H bonds. Why is this important? Because protic solvents can participate in hydrogen bonding, which is a powerful intermolecular force. Additionally, these O-H or N-H bonds can serve as a source of protons (H+).
- **Aprotic solvents** may have hydrogens on them somewhere, but they lack O-H or N-H bonds, and therefore **cannot hydrogen bond** with themselves.

For the average first semester student, these distinctions come up the most in substitution reactions, where hydrogen bonding solvents tend to decrease the reactivity of nucleophiles; polar aprotic solvents, on the other hand, do not.

There are 3 types of solvents commonly encountered: nonpolar, polar aprotic, and polar protic. (There ain't such a thing as a non-polar protic solvent).

OK, enough yammering. Here are some (hopefully useful) tables.

Nonpolar solvents:

These solvents have low dielectric constants (<5) and are not good solvents for charged species such as anions. However diethyl ether (Et2O) is a common solvent for Grignard reactions; its lone pairs are Lewis basic and can help to solvate the Mg cation.

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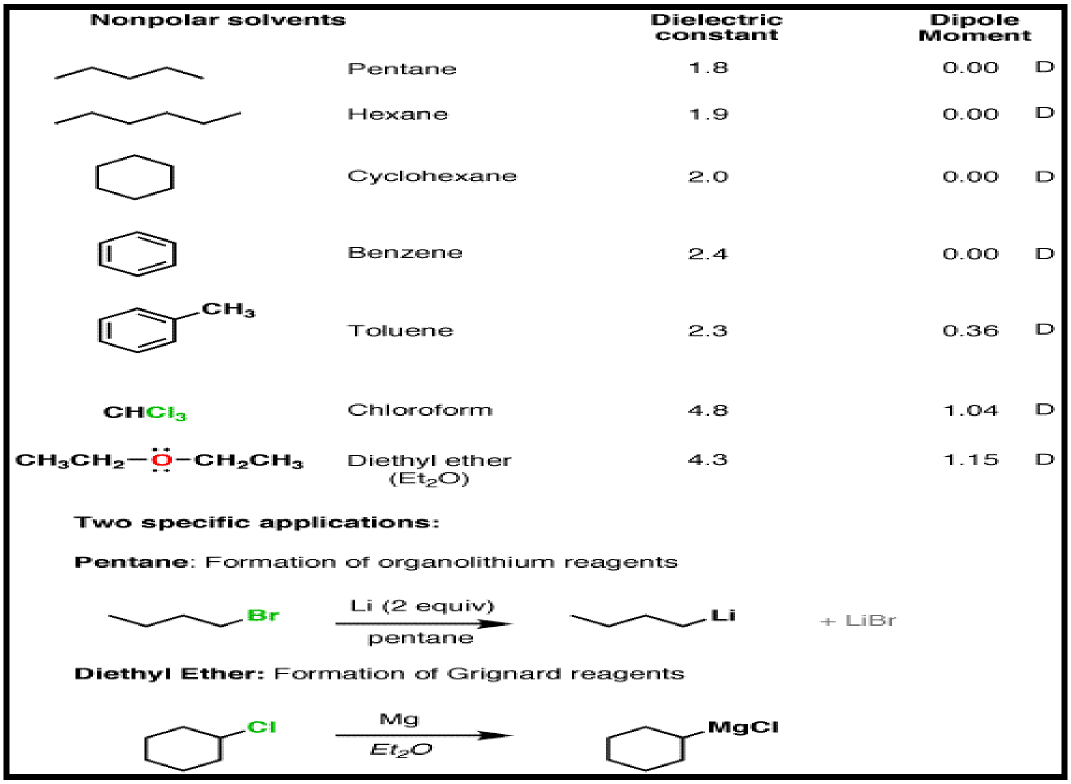
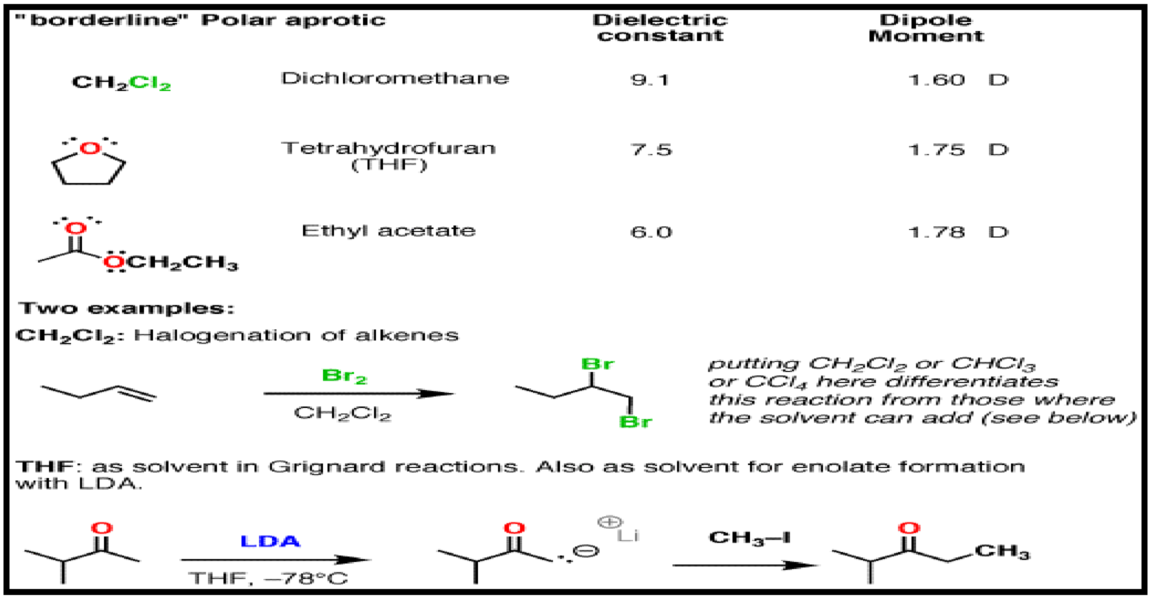


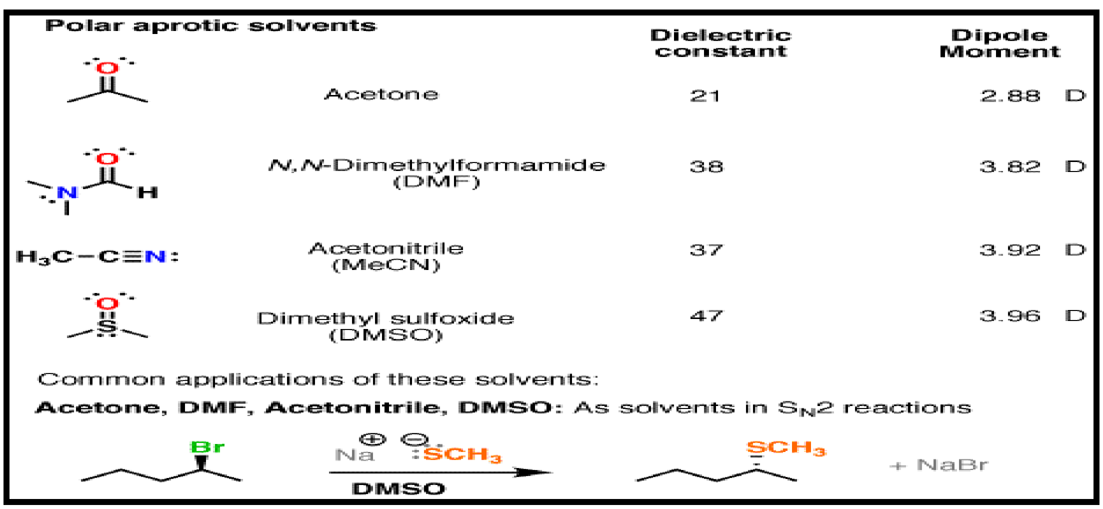
Polar aprotic solvents

These solvents have moderately higher dielectric constants than the nonpolar solvents (between 5 and 20). Since they have intermediate polarity they are good "general purpose" solvents for a wide range of reactions. They are "aprotic" because they lack O-H or N-H bonds. For our purposes they don't participate in reactions: they serve only as the medium.



Polar aprotic solvents

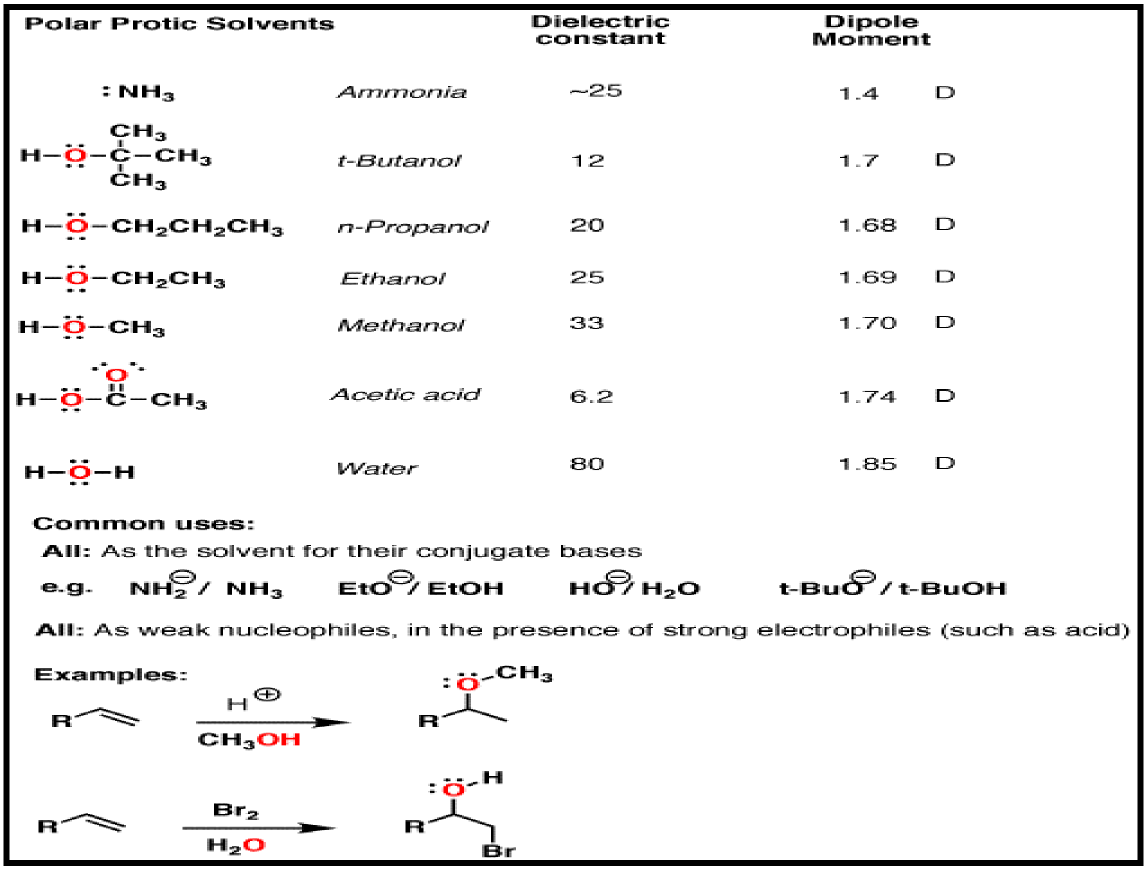
These solvents all have large dielectric constants (>20) and large dipole moments, but they do not participate in hydrogen bonding (no O-H or N-H bonds). Their high polarity allows them to dissolve charged species such as various anions used as nucleophiles (e.g. CN(-), HO(-), etc.). The lack of hydrogen bonding in the solvent means that these nucleophiles are relatively "free" in solution, making them more reactive. For our purposes these solvents do not participate in the reaction.



Polar protic solvents

Polar protic solvents tend to have high dielectric constants and high dipole moments. Furthermore, since they possess O-H or N-H bonds, they can also participate in hydrogen bonding. These solvents can also serve as acids (sources of protons) and weak nucleophiles (forming bonds with strong electrophiles).

They are most commonly used as the solvent for their conjugate bases. (e.g. H2O is used as the solvent for HO(-); EtOH is used as the solvent for EtO(-).)



Polar Protic Solvents		Dielectric constant	Dipole Moment
$:NH_3$	*Ammonia*	~25	1.4 D
$H{-}O{-}C(CH_3)_3$	*t-Butanol*	12	1.7 D
$H{-}O{-}CH_2CH_2CH_3$	*n-Propanol*	20	1.68 D
$H{-}O{-}CH_2CH_3$	*Ethanol*	25	1.69 D
$H{-}O{-}CH_3$	*Methanol*	33	1.70 D
$H{-}O{-}C(=O){-}CH_3$	*Acetic acid*	6.2	1.74 D
$H{-}O{-}H$	*Water*	80	1.85 D

Common uses:

All: As the solvent for their conjugate bases

e.g. $NH_2^{\ominus}$ / NH_3 $EtO^{\ominus}$ / EtOH $HO^{\ominus}$ / H_2O t-$BuO^{\ominus}$ / t-BuOH

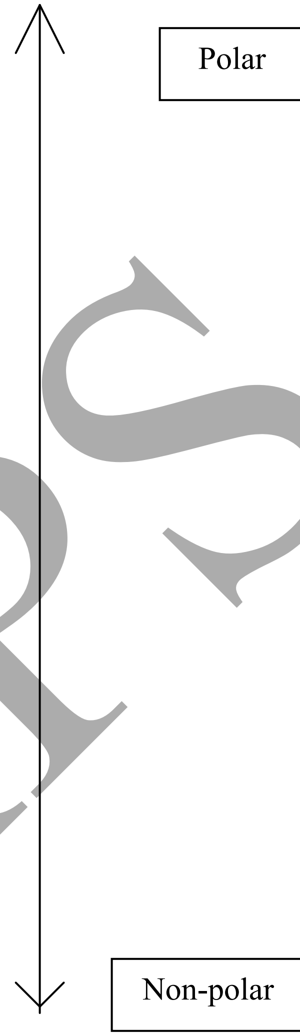
All: As weak nucleophiles, in the presence of strong electrophiles (such as acid)

Examples:

These types of solvents are by far the most likely to participate in reactions. There are many examples (too many to list) where a polar protic solvent such as water, methanol, or ethanol can serve as the nucleophile in a reaction, often when a strong electrophile (such as an acid) is present. So if you see this type of solvent

Polarity of Solvents

Water
Acetic Acid
Ethyleneglycol
Methanol
Ethanol
Isopropanol
Pyridine
Acetonitrile
Nitromethane
Diehylamine
Aniline
Dimethylsulfoxide
Ethylacetate
Dioxane
Acetone
Dicholoroethane
Tetrahydrofuran
Dicholoromethane
Chloroform
Diethylether
Benzene
Toluene
Xylene
Carbontetrachloride
Cyclohexane
Petroleum ether
Hexane
Pentane



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Polarity Index	Solvent	Polarity Index	Solvent	Solubility in Water (%)
6.2	Acetic Acid	0	Heptane	0.0003
5.1	Acetone	0	Hexane	0.001
5.8	Acetonitrile	0	Pentane	0.004
2.7	Benzene	0.2	Cyclohexane	0.01
4	n-Butanol	1	Trichloroethylene	0.11
3.9	Butyl Acetate	1.6	Carbon Tetrachloride	0.08
1.6	Carbon Tetrachloride	2.2	Di-Iso-Propyl Ether	0
4.1	Chloroform	2.4	Toluene	0.051
0.2	Cyclohexane	2.5	Methyl-t-Butyl Ether	4.8
3.5	1,2-Dichloroethane	2.5	Xylene	0.018
3.1	Dichloromethane	2.7	Benzene	0.18
6.4	Dimethylformamide	2.8	DiEthyl Ether	6.89
7.2	Dimethyl Sulfoxide	3.1	Dichloromethane	1.6
4.8	Dioxane	3.5	1,2-Dichloroethane	0.81
5.2	Ethanol	3.9	Butyl Acetate	7.81
4.4	Ethyl Acetate	3.9	Iso-Propanol	100
2.8	DiEthyl Ether	4	n-Butanol	0.43
0	Heptane	4	Tetrahydrofuran	100
0	Hexane	4	n-Propanol	100
5.1	Methanol	4.1	Chloroform	0.815
2.5	Methyl-t-Butyl Ether	4.4	Ethyl Acetate	8.7
4.7	2-Butanone	4.7	2-Butanone	24
0	Pentane	4.8	Dioxane	100

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4	n-Propanol	5.1	Acetone	100
3.9	Iso-Propanol	5.1	Methanol	100
2.2	Di-Iso-Propyl Ether	5.2	Ethanol	100
4	Tetrahydrofuran	5.8	Acetonitrile	100
2.4	Toluene	6.2	Acetic Acid	100
1	Trichloroethylene	6.4	Dimethylformamide	100
9	Water	7.2	Dimethyl Sulfoxide	100
2.5	Xylene	9	Water	100

Properties of Organic Solvents

The values in the table below except as noted have been extracted from online and hardbound compilations . Values for relative polarity, eluant strength, threshold limits and vapor pressure have been extracted from: Christian Reichardt, *Solvents and Solvent Effects in Organic Chemistry*, Wiley-VCH Publishers, 3rd ed., **2003**.

Table 1 arranged alphabetically, **Table 2 arranged according to increasing polarity**

Solvent	formula	boilingpoint(^{o}C)	meltingpoint(^{o}C)	density (g/mL)	solubilityin H_2O[1] (g/100g)	relative polarity[2]
acetic acid	$C_2H_4O_2$	118	16.6	1.049	M	0.648
acetone	C_3H_6O	56.2	-94.3	0.786	M	0.355
acetonitrile	C_2H_3N	81.6	-46	0.786	M	0.460
acetyl acetone	$C_5H_8O_2$	140.4	-23	0.975	16	0.571
2-aminoethanol	C_2H_7NO	170.9	10.5	1.018	M	0.651
aniline	C_6H_7N	184.4	-6.0	1.022	3.4	0.420
anisole	C_7H_8O	153.7	-37.5	0.996	0.10	0.198
benzene	C_6H_6	80.1	5.5	0.879	0.18	0.111
benzonitrile	C_7H_5N	205	-13	0.996	0.2	0.333
benzyl alcohol	C_7H_8O	205.4	-15.3	1.042	3.5	0.608

1-butanol	$C_4H_{10}O$	117.6	-89.5	0.81	7.7	0.586
2-butanol	$C_4H_{10}O$	99.5	-114.7	0.808	18.1	0.506
***i*-butanol**	$C_4H_{10}O$	107.9	-108.2	0.803	8.5	0.552
2-butanone	C_4H_8O	79.6	-86.3	0.805	25.6	0.327
***t*-butyl alcohol**	$C_4H_{10}O$	82.2	25.5	0.786	M	0.389
carbon disulfide	CS_2	46.3	-111.6	1.263	0.2	0.065
carbon tetrachl oride	CCl_4	76.7	-22.4	1.594	0.08	0.052
chlorobenzene	C_6H_5Cl	132	-45.6	1.106	0.05	0.188
chloroform	$CHCl_3$	61.2	-63.5	1.498	0.8	0.259
cyclohexane	C_6H_{12}	80.7	6.6	0.779	0.005	0.006
cyclohexanol	$C_6H_{12}O$	161.1	25.2	0.962	4.2	0.509
cyclohexanone	$C_6H_{10}O$	155.6	-16.4	0.948	2.3	0.281
di-n-butylphthalate	$C_{16}H_{22}O_4$	340	-35	1.049	0.0011	0.272
1,1-dichloroethane	$C_2H_4Cl_2$	57.3	-97.0	1.176	0.5	0.269
diethylene glyc ol	$C_4H_{10}O_3$	245	-10	1.118	M	0.713
diglyme	$C_6H_{14}O_3$	162	-64	0.945	M	0.244
dimethoxyethan e (glyme)	$C_4H_{10}O_2$	85	-58	0.868	M	0.231
N,N-dimethylaniline	$C_8H_{11}N$	194.2	2.4	0.956	0.14	0.179
dimethylformam ide (DMF)	C_3H_7NO	153	-61	0.944	M	0.386
dimethylphthala te	$C_{10}H_{10}O_4$	283.8	1	1.190	0.43	0.309
dimethylsulfoxi de (DMSO)	C_2H_6OS	189	18.4	1.092	M	0.444
dioxane	$C_4H_8O_2$	101.1	11.8	1.033	M	0.164

ethanol	C_2H_6O	78.5	-114.1	0.789	M	0.654
ether	$C_4H_{10}O$	34.6	-116.3	0.713	7.5	0.117
ethyl acetate	$C_4H_8O_2$	77	-83.6	0.894	8.7	0.228
ethyl acetoacetate	$C_6H_{10}O_3$	180.4	-80	1.028	2.9	0.577
ethyl benzoate	$C_9H_{10}O_2$	213	-34.6	1.047	0.07	0.228
ethylene glycol	$C_2H_6O_2$	197	-13	1.115	M	0.790
glycerin	$C_3H_8O_3$	290	17.8	1.261	M	0.812
heptane	C_7H_{16}	98	-90.6	0.684	0.0003	0.012
1-heptanol	$C_7H_{16}O$	176.4	-35	0.819	0.17	0.549
hexane	C_6H_{14}	69	-95	0.655	0.0014	0.009
1-hexanol	$C_6H_{14}O$	158	-46.7	0.814	0.59	0.559
methanol	CH_4O	64.6	-98	0.791	M	0.762
methyl acetate	$C_3H_6O_2$	56.9	-98.1	0.933	24.4	0.253
methyl *t*-butyl ether (MTBE)	$C_5H_{12}O$	55.2	-109	0.741	4.8	0.124
methylene chlor ide	CH_2Cl_2	39.8	-96.7	1.326	1.32	0.309
1-octanol	$C_8H_{18}O$	194.4	-15	0.827	0.096	0.537
pentane	C_5H_{12}	36.1	-129.7	0.626	0.004	0.009
1-pentanol	$C_5H_{12}O$	138.0	-78.2	0.814	2.2	0.568
2-pentanol	$C_5H_{12}O$	119.0	-50	0.810	4.5	0.488
3-pentanol	$C_5H_{12}O$	115.3	-8	0.821	5.1	0.463
2-pentanone	$C_5H_{10}O$	102.3	-76.9	0.809	4.3	0.321
3-pentanone	$C_5H_{12}O$	101.7	-39.8	0.814	3.4	0.265
1-propanol	C_3H_8O	97	-126	0.803	M	0.617
2-propanol	C_3H_8O	82.4	-88.5	0.785	M	0.546
pyridine	C_5H_5N	115.5	-42	0.982	M	0.302
tetrahydrofuran(	C_4H_8O	66	-108.4	0.886	30	0.207

THF)						
toluene	C_7H_8	110.6	-93	0.867	0.05	0.099
water	H_2O	100.00	0.00	0.998	M	1.000
water, heavy	D_2O	101.3	4	1.107	M	0.991
***p*-xylene**	C_8H_{10}	138.3	13.3	0.861	0.02	0.074

1 M = miscible.
2 The values for relative polarity are normalized from measurements of solvent shifts of absorption spectra and were extracted from Christian Reichardt, *Solvents and Solvent Effects in Organic Chemistry*, Wiley-VCH Publishers, 3rd ed., **2003.**
3 Snyder's empirical eluant strength parameter for alumina. Extracted from Reichardt, page 495.
4 Threshold limits for exposure. Extracted from Reichardt, pages 501-502.

TABLE 2

Solvent	formula	Boiling point(°C)	Melting point(°C)	density (g/mL)	Solubility in H_2O[1] (g/100g)	**relative polarity** [2]	thresholdlimits[4](ppm)
cyclohexane	C_6H_{12}	80.7	6.6	0.779	0.005	**0.006**	100
pentane	C_5H_{12}	36.1	-129.7	0.626	0.0039	**0.009**	600
hexane	C_6H_{14}	69	-95	0.655	0.0014	**0.009**	50
heptane	C_7H_{16}	98	-90.6	0.684	0.0003	**0.012**	400
carbon tetrachloride	CCl_4	76.7	-22.4	1.594	0.08	**0.052**	5
carbon disulfide	CS_2	46.3	-111.6	1.263	0.2	**0.065**	10
p-xylene	C_8H_{10}	138.3	13.3	0.861	0.02	**0.074**	100
toluene	C_7H_8	110.6	-93	0.867	0.05	**0.099**	50
benzene	C_6H_6	80.1	5.5	0.879	0.18	**0.111**	0.5
ether	$C_4H_{10}O$	34.6	-116.3	0.713	7.5	**0.117**	400
methyl *t*-butyl ether (MTBE)	$C_5H_{12}O$	55.2	-109	0.741	4.8	**0.124**	

diethylamine	$C_4H_{11}N$	56.3	-48	0.706	M	**0.145**	5
dioxane	$C_4H_8O_2$	101.1	11.8	1.033	M	**0.164**	20
N,N-dimethylaniline	$C_8H_{11}N$	194.2	2.4	0.956	0.14	**0.179**	
chlorobenzene	C_6H_5Cl	132	-45.6	1.106	0.05	**0.188**	10
anisole	C_7H_8O	153.7	-37.5	0.996	0.10	**0.198**	
tetrahydrofuran (THF)	C_4H_8O	66	-108.4	0.886	30	**0.207**	200
ethyl acetate	$C_4H_8O_2$	77	-83.6	0.894	8.7	**0.228**	400
ethyl benzoate	$C_9H_{10}O_2$	213	-34.6	1.047	0.07	**0.228**	
dimethoxyethane (glyme)	$C_4H_{10}O_2$	85	-58	0.868	M	**0.231**	
diglyme	$C_6H_{14}O_3$	162	-64	0.945	M	**0.244**	
methyl acetate	$C_3H_6O_2$	56.9	-98.1	0.933	24.4	**0.253**	200
chloroform	$CHCl_3$	61.2	-63.5	1.498	0.8	**0.259**	10
3-pentanone	$C_5H_{12}O$	101.7	-39.8	0.814	3.4	**0.265**	200
1,1-dichloroethane	$C_2H_4Cl_2$	57.3	-97.0	1.176	0.5	**0.269**	100
di-n-butyl phthalate	$C_{16}H_{22}O_4$	340	-35	1.049	0.0011	**0.272**	
cyclohexanone	$C_6H_{10}O$	155.6	-16.4	0.948	2.3	**0.281**	25
pyridine	C_5H_5N	115.5	-42	0.982	M	**0.302**	5
dimethylphthalate	$C_{10}H_{10}O_4$	283.8	1	1.190	0.43	**0.309**	
methylene chloride	CH_2Cl_2	39.8	-96.7	1.326	1.32	**0.309**	50
2-pentanone	$C_5H_{10}O$	102.3	-76.9	0.809	4.3	**0.321**	
2-butanone	C_4H_8O	79.6	-86.3	0.805	25.6	**0.327**	200

1,2-dichloroethane	$C_2H_4Cl_2$	83.5	-35.4	1.235	0.87	**0.327**	
benzonitrile	C_7H_5N	205	-13	0.996	0.2	**0.333**	10
acetone	C_3H_6O	56.2	-94.3	0.786	M	**0.355**	500
dimethylformamide (DMF)	C_3H_7NO	153	-61	0.944	M	**0.386**	10
t-butyl alcohol	$C_4H_{10}O$	82.2	25.5	0.786	M	**0.389**	100
aniline	C_6H_7N	184.4	-6.0	1.022	3.4	**0.420**	2
dimethylsulfoxide (DMSO)	C_2H_6OS	189	18.4	1.092	M	**0.444**	
acetonitrile	C_2H_3N	81.6	-46	0.786	M	**0.460**	20
3-pentanol	$C_5H_{12}O$	115.3	-8	0.821	5.1	**0.463**	
2-pentanol	$C_5H_{12}O$	119.0	-50	0.810	4.5	**0.488**	
2-butanol	$C_4H_{10}O$	99.5	-114.7	0.808	18.1	**0.506**	100
cyclohexanol	$C_6H_{12}O$	161.1	25.2	0.962	4.2	**0.509**	50
1-octanol	$C_8H_{18}O$	194.4	-15	0.827	0.096	**0.537**	
2-propanol	C_3H_8O	82.4	-88.5	0.785	M	**0.546**	400
1-heptanol	$C_7H_{16}O$	176.4	-35	0.819	0.17	**0.549**	
i-butanol	$C_4H_{10}O$	107.9	-108.2	0.803	8.5	**0.552**	
1-hexanol	$C_6H_{14}O$	158	-46.7	0.814	0.59	**0.559**	
1-pentanol	$C_5H_{12}O$	138.0	-78.2	0.814	2.2	**0.568**	
acetyl acetone	$C_5H_8O_2$	140.4	-23	0.975	16	**0.571**	
ethyl acetoacetate	$C_6H_{10}O_3$	180.4	-80	1.028	2.9	**0.577**	
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benzyl alcohol	C_7H_8O	205.4	-15.3	1.042	3.5	**0.608**	
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acetic acid	$C_2H_4O_2$	118	16.6	1.049	M	**0.648**	10

2-aminoethanol	C_2H_7NO	170.9	10.5	1.018	M	**0.651**	3
ethanol	C_2H_6O	78.5	-114.1	0.789	M	**0.654**	1000
diethylene glycol	$C_4H_{10}O_3$	245	-10	1.118	M	**0.713**	
methanol	CH_4O	64.6	-98	0.791	M	**0.762**	200
ethylene glycol	$C_2H_6O_2$	197	-13	1.115	M	**0.790**	
glycerin	$C_3H_8O_3$	290	17.8	1.261	M	**0.812**	
water, heavy	D_2O	101.3	4	1.107	M	**0.991**	
water	H_2O	100.00	0.00	0.998	M	**1.000**	

NMR Chemical Shifts of Common Laboratory Solvents as Trace Impurities *Organometallics*, 2010, 29 (9), pp 2176–2179

Table 1. ^{1}H NMR Data[a]

	proton	mult	THF-*d*$_8$	$CDCl_3$	C_6D_6	$(CD_3)_2CO$	$(CD_3)_2SO$	TFE-*d*$_3$	CD_3OD
solvent residual signals			1.72	7.26	7.16	2.05	2.50	5.02	3.31
			3.58					3.88	
water	OH	s	2.46	1.56	0.40	2.84[b]	3.33[b]	3.66	4.87
acetic acid	CH_3	s	1.89	2.10	1.52	1.96	1.91	2.06	1.99
acetone	CH_3	s	2.05	2.17	1.55	2.09	2.09	2.19	2.15
acetonitrile	CH_3	s	1.95	2.10	0.58	2.05	2.07	1.95	2.03
benzene	CH	s	7.31	7.36	7.15	7.36	7.37	7.36	7.33
tert -butyl alcohol	CH_3	s	1.15	1.28	1.05	1.18	1.11	1.28	1.40
	OH	s[c]	3.16		0.63		4.19	2.20	
chloroform	CH	s	7.89	7.26	6.15	8.02	8.32	7.33	7.90
18-crown-6	CH_2	s	3.57	3.67	3.39	3.59	3.51	3.64	3.64
cyclohexane	CH_2	s	1.44	1.43	1.40	1.43	1.40	1.47	1.45

1,2-dichloroethane	CH_2	s	3.77	3.73	2.90	3.87	3.90	3.71	3.78
dichloromethane	CH_2	s	5.51	5.30	4.27	5.63	5.76	5.24	5.49
diethyl ether	CH_3	t, 7	1.12	1.21	1.11	1.11	1.09	1.20	1.18
	CH_2	q, 7	3.38	3.48	3.26	3.41	3.38	3.58	3.49
diglyme	CH_2	m	3.43	3.65	3.46	3.56	3.51	3.67	3.61
	CH_2	m	3.53	3.57	3.34	3.47	3.38	3.62	3.58
	OCH_3	s	3.28	3.39	3.11	3.28	3.24	3.41	3.35
dimethylformamide	CH	s	7.91	8.02	7.63	7.96	7.95	7.86	7.97
	CH_3	s	2.88	2.96	2.36	2.94	2.89	2.98	2.99
	CH_3	s	2.76	2.88	1.86	2.78	2.73	2.88	2.86
1,4-dioxane	CH_2	s	3.56	3.71	3.35	3.59	3.57	3.76	3.66
DME	CH_3	s	3.28	3.40	3.12	3.28	3.24	3.40	3.35
	CH_2	s	3.43	3.55	3.33	3.46	3.43	3.61	3.52
ethane	CH_3	s	0.85	0.87	0.80	0.83	0.82	0.85	0.85
ethanol	CH_3	t, 7	1.10	1.25	0.96	1.12	1.06	1.22	1.19
	CH_2	q, 7[d]	3.51	3.72	3.34	3.57	3.44	3.71	3.60
	OH	s[c,d]	3.30	1.32	0.50	3.39	4.63		
ethyl acetate	CH_3CO	s	1.94	2.05	1.65	1.97	1.99	2.03	2.01
	CH_2CH_3	q, 7	4.04	4.12	3.89	4.05	4.03	4.14	4.09
	CH_2CH_3	t, 7	1.19	1.26	0.92	1.20	1.17	1.26	1.24
ethylene	CH_2	s	5.36	5.40	5.25	5.38	5.41	5.40	5.39
ethylene glycol	CH_2	s[e]	3.48	3.76	3.41	3.28	3.34	3.72	3.59
H grease[f]	CH_3	m	0.85−0.91	0.84−0.87	0.90−0.98	0.90	0.82−0.88	0.88−0.94	0.86−0.93
	CH_2	br s	1.29	1.25	1.32	1.29	1.24	1.33	1.29
hexamethylbenzene	CH_3	s	2.18	2.24	2.13	2.17	2.14	2.24	2.19
n-hexane	CH_3	t, 7	0.89	0.88	0.89	0.88	0.86	0.91	0.90
	CH_2	m	1.29	1.26	1.24	1.28	1.25	1.31	1.29
HMDSO	CH_3	s	0.07	0.07	0.12	0.07	0.06	0.08	0.07
HMPA	CH_3	d,9.5	2.58	2.65	2.40	2.59	2.53	2.63	2.64
hydrogen	H_2	s	4.55	4.62	4.47	4.54	4.61	4.53	4.56
imidazole	CH(2)	s	7.48	7.67	7.33	7.62	7.63	7.61	7.67
	CH(4,5)	s	6.94	7.10	6.90	7.04	7.01	7.03	7.05

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methane	CH_4	s	0.19	0.22	0.16	0.17	0.20	0.18	0.20
methanol	CH_3	s[g]	3.27	3.49	3.07	3.31	3.16	3.44	3.34
	OH	s[c,g]	3.02	1.09		3.12	4.01		
nitromethane	CH_3	s	4.31	4.33	2.94	4.43	4.42	4.28	4.34
n-pentane	CH_3	t, 7	0.89	0.88	0.87	0.88	0.86	0.90	0.90
	CH_2	m	1.31	1.27	1.23	1.27	1.27	1.33	1.29
propane	CH_3	t, 7.3	0.90	0.90	0.86	0.88	0.87	0.90	0.91
	CH_2	sept, 7.3	1.33	1.32	1.26	1.31	1.29	1.33	1.34
2-propanol	CH_3	d, 6	1.08	1.22	0.95	1.10	1.04	1.20	1.50
	CH	sept, 6	3.82	4.04	3.67	3.90	3.78	4.05	3.92
propylene	CH_3	dt, 6.4, 1.5	1.69	1.73	1.55	1.68	1.68	1.70	1.70
	CH_2(1)	dm, 10	4.89	4.94	4.95	4.90	4.94	4.93	4.91
	CH_2(2)	dm, 17	4.99	5.03	5.01	5.00	5.03	5.03	5.01
	CH	m	5.79	5.83	5.72	5.81	5.80	5.87	5.82
pyridine	CH(2,6)	m	8.54	8.62	8.53	8.58	8.58	8.45	8.53
	CH(3,5)	m	7.25	7.29	6.66	7.35	7.39	7.40	7.44
	CH(4)	m	7.65	7.68	6.98	7.76	7.79	7.82	7.85
pyrrole	NH	br t	9.96	8.40	7.80	10.02	10.75		
	CH(2,5)	m	6.66	6.83	6.48	6.77	6.73	6.84	6.72
	CH(3,4)	m	6.02	6.26	6.37	6.07	6.01	6.24	6.08
pyrrolidine[h]	CH_2(2,5)	m	2.75	2.87	2.54		2.67	3.11	2.80
	CH_2(3,4)	m	1.59	1.68	1.33		1.55	1.93	1.72
silicone grease	CH_3	s	0.11	0.07	0.29	0.13	−0.06	0.16	0.10
tetrahydrofuran	CH_2(2,5)	m	3.62	3.76	3.57	3.63	3.60	3.78	3.71
	CH_2(3,4)	m	1.79	1.85	1.40	1.79	1.76	1.91	1.87
toluene	CH_3	s	2.31	2.36	2.11	2.32	2.30	2.33	2.32
	CH(2,4,6)	m	7.10	7.17	7.02	7.10−7.20	7.18	7.10−7.30	7.16
	CH(3,5)	m	7.19	7.25	7.13	7.10−7.20	7.25	7.10−7.30	7.16
triethylamine	CH_3	t, 7	0.97	1.03	0.96	0.96	0.93	1.31	1.05
	CH_2	q,7	2.46	2.53	2.40	2.45	2.43	3.12	2.58

a-Except for the compounds in solutions 8−10, as well as the gas samples, hexamethylbenzene, and the corrected values mentioned in the **Supporting Information**, all data for the solvents $CDCl_3$, C_6D_6, $(CD_3)_2CO$, $(CD_3)_2SO$, CD_3CN, CD_3OD, and D_2O were previously reported in ref **2**.

b-A signal for HDO is also observed in $(CD_3)_2SO$ (3.30 ppm) and $(CD_3)_2CO$ (2.81 ppm), often seen as a 1:1:1 triplet ($^2J_{H,D}$ = 1 Hz).
c-Not all OH signals were observable.
d-In some solvents, the coupling interaction between the CH_2 and the OH protons may be observed (J = 5 Hz).
e-In CD_3CN, the OH proton was seen as a multiplet at 2.69 ppm, as well as extra coupling to the CH_2 resonance.
f-Apiezon brand H grease.
g-In some solvents, a coupling interaction between the CH_3 and the OH protons may be observed (J = 5.5 Hz).
h-Pyrrolidine was observed to react with $(CD_3)_2CO$.

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