Intermediates

High-performance solvents

Glymes, 1,3-Dioxolane and 1,4-Dioxane

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BASF –
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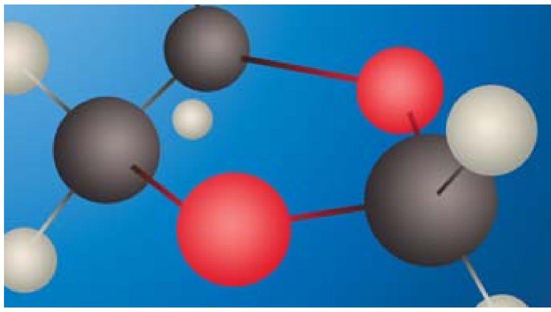
BASF is the world's leading chemical company: The Chemical Company. Its portfolio ranges from chemicals, plastics, performance products and crop protection products to oil and gas. We combine economic success, social responsibility and environmental protection. Through science and innovation we enable our customers in almost all industries to meet the current and future needs of society. Our products and system solutions contribute to conserving resources, ensuring healthy food and nutrition and helping to improve the quality of life. We have summed up this contribution in our corporate purpose: We create chemistry for a sustainable future.

Top intermediates supplier

The BASF Group's Intermediates division develops, produces and markets a comprehensive portfolio of more than 600 intermediates around the world. The most important of the division's product groups include amines, diols, polyalcohols, acids and specialties. Among other applications, intermediates are used as starting materials for coatings, plastics, pharmaceuticals, textile fibers, detergents and crop protectants. Innovative intermediates from BASF help to improve the properties of final products and the efficiency of production processes. The ISO 9001:2000-certified Intermediates division operates plants at production sites in Europe, Asia and the Americas.

High-performance solvents



Glymes

Glycol diethers, or glymes, are aprotic, saturated polyethers that offer high solvency, high stability in strong bases and moderate stability in acid solutions. Glymes efficiently solvate cations, increasing anion reactivity, and thus can increase both selectivity and reaction rates.

Most glymes are water-soluble, but a range of solubility and boiling points are available. The polyether structure produces only weak associations between glyme molecules, and is responsible for the low viscosity and excellent wetting properties of these solvents.

A further structural feature of glymes that contributes significantly to their usefulness involves the arrangement of oxygen atoms, as ether linkages, at two-carbon intervals. The model of the diglyme molecule (picture above) illustrates this periodic recurrence of oxygen atoms separated by two carbon atoms. This steric arrangement, analogous to that of crown ethers, gives glymes the ability to form complexes with many cations.

Glycol diethers have a wide range of solubilities and boiling points. They are used as reaction solvents and in closed loop applications such as gas scrubbing and in refrigeration systems. The higher molecular weight glymes beginning with ethyl diglyme are suitable for emissive applications such as coatings, inks, adhesives and in cleaning compounds. The lower molecular weight glymes should not be used in emissive applications due to their reproductive toxicity.

1,3-Dioxolane

1,3-Dioxolane is an excellent solvent for polar polymers. It is used to produce coatings, films, in paint stripping formulations, for photoresist removal and as a general clean-up solvent for epoxy and urethane.

1,4-Dioxane

1,4-Dioxane is an aprotic, relatively inert solvent capable of solubilizing a large range of organic and even some inorganic compounds and miscible with water in all proportions. It is ideally suited for use in closed-loop applications such as vented reactors for the manufacture of active pharmaceutical ingredients (APIs) and fine chemicals.

Content of the brochure:

Glymes family – product overview by boiling point

Higlyme
Highly ethoxylated diether of a high-molecular-weight alcohol
[366009-01-0]

Polyglyme
CH_3-O-(CH_2CH_2-O)$_n$-CH_3
Poly(ethylene glycol) dimethyl ether
[24991-55-7]

BP 275C

Ethyl diglyme
CH_3CH_2-O-(CH_2CH_2-O)$_2$-CH_2CH_3
Diethylene glycol diethyl ether
[112-36-7]

BP 189C

Ethyl glyme
CH_3CH_2-O-CH_2CH_2-O-CH_2CH_3
Ethylene glycol diethyl ether
[629-14-1]

BP 121C

BP 277C

Tetraglyme
CH_3-O-(CH_2CH_2-O)$_4$-CH_3
Tetraethylene glycol dimethyl ether
[143-24-8]

BP 251C

Butyl diglyme
$CH_3CH_2CH_2CH_2$-O-(CH_2CH_2-O)$_2$-$CH_2CH_2CH_2CH_3$
Diethylene glycol dibutyl ether
[112-73-2]

BP 216C

Triglyme
CH_3-O-(CH_2CH_2-O)$_3$-CH_3
Triethylene glycol dimethyl ether
[112-49-2]

BP 175C

Proglyme
CH_3-O-(CH_2CHCH_3-O)$_2$-CH_3
Dipropylene glycol dimethyl ether
[111109-77-4]

BP 160C

Diglyme
CH_3-O-(CH_2CH_2-O)$_2$-CH_3
Diethylene glycol dimethyl ether
[111-96-6]

BP 84C

Monoglyme
CH_3-O-CH_2CH_2-O-CH_3
Ethylene glycol dimethyl ether
[110-71-4]

Common name
Structure
IUPAC name
Chemical abstract service registry number [CAS]

Glymes for high-performance coatings

BASF's selection of high-performance solvents enables coatings formulators to maximize performance.

Higlyme and proglyme are powerful co-solvents that strongly complexes with pigments in coating formulations.

Higlyme

- VOC-exempt in Europe
- 6% VOC in the United States
- Most powerful emulsifier
- Superior wetting agent

Proglyme

- Dipropylene glycol derived
- Long used for one- and two-component polyurethanes
- Emulsify and improve the appearance of coatings
- Part of the P-series glymes with excellent toxicity profile
- Coalescent with high solvency and low odor

Glymes compared to common ester alcohol and PCBTF

	Higlyme	Proglyme	Common ester alcohol	PCBTF
Chemical description	Glycol diether	P-series glycol diether	Ester alcohol	Halogenated aromatic
Coalescent	yes	yes	yes	no
Odor	mild ethereal	mild ethereal	ester	no
US VOC-exempt?	no	no	no	yes
Rel Evap. rate (nBuAc = 1)	< 0.01	0.1	0.002	0.9
BP [C]	275	175	254	139
Density [g/ml]	1.03	0.9	0.95	1.34
% in H_2O	100	37	0.1	0
% H_2O in	100	4.5	3.0	0
Specific heat [J/g·K]	2.01	2.03	1.72	1.09

Glymes in high-performance inks

Graphics arts – ink solvents

Glymes are useful in a variety of ink formulations, including inkjet inks that are stable and do not clog tiny orifices, high-end writing inks with low viscosity and good stability, conductive inks and pastes, as well as magnetic inks.

Use inks formulated with BASF high-performance solvents to:

- Maximize color print quality and durability
- Increase cartridge reliability and endcap/idle times
- Eliminate odor and toxic solvents
- Minimize dispersant and pigment cost
- Choose boiling points to control droplet size and to concentrate dyes on the surface

Properties

- High solvency provides stability and maximum color density
- Strongly complexes with pigments
- Low odor
- Prevents inkjet clogging
- Acts as an emulsifier and humectant
- Higlyme and Tetraglyme are 94% non-VOC by EPA method 24

Aqueous coating compositions useful in coating substrates immediately after printing with oil-based inks contain glymes. These coatings accelerate bonding and drying of the ink, which permits faster printing.

Glymes are also used in formulations of deletion fluids for positive printing plates, as retouching agents for lithographic printing, waterless lithographic plates, and in cleaning agents for removing inks from printing machines.

Glymes are usefull as well in correction fluids and re-touching liquids for toner images, in photosensitive coating solutions in diazo processes, in alkaline processing solutions in diffusion transfer photography. For desensitizing compositions for pressure-sensitive copying paper. Additionally, they are used as low-odor white-board cleaners.

For bright and durable inks

Ink formulators use solvents as key ingredients to improve image appearance and durability. The ability of glycol diethers to disperse pigments in aqueous and solvent-based systems enables formulators to reduce cost and increase ink stability. The choice of mix of medium boiling point controls evaporation rate, to keep the pigment or dye concentrated on the paper suface, for maximum color density.

Examples of commercial inks based on BASF glycol diethers:

Specialty solvent cyan ink	
Component	% by weight
BASF Proglyme	< 30
Other solvents	< 70
Copolymers	< 8.5

Highest quality with advanced magenta pigments, smudge-, fade- and water-resistant	
Component	% by weight
BASF Ethyl diglyme	50 – 70
BASF Tetraglyme	10 – 20
Other solvents	6 – 25
Pigment, dyes or carbon black	1 – 5
Resins and additives	1 – 10

Humectants as strong emulsifiers

The use of up to 20% high-boiling tetraglyme or higlyme improves cartridge life and idle (also known as decap) times. Tetraglyme and higlyme are strong emulsifiers to stabilize ink and function as humectants to keep orifices clear.

UV, wide-format, eco-ink and low-odor ink

Glymes will increase solvency, decrease ink viscosity and allow printing on an extended range of materials such as polymer films. They also enhance the solvency of soy-based and ecosolv inks and allow ink formulators to improve performance to adapt to increasing demands for color fastness, optical density and sharpness.

Glymes as reaction solvents

Pharma and fine chemicals synthesis

Due to their high stability and solvency, glymes are widely used as reaction media for processes involving alkali metal hydroxides, sodium hydride, and alkali metals. Grignard reaction yields can be increased and purification costs reduced by using glymes as reaction solvents.

Sodium borohydride at high temperature can be substituted for lithium aluminum hydride in some reductions. Carried out in glymes sodium aluminum hydride can be prepared directly from the elements in diglyme.

Diglyme is the solvent of choice when preparing aryl sulfides via use of sodium tetrafluoroborate as a catalyst. Diglyme is also a key to the efficient synthesis of the anti-AIDS drug Nevirapine.

Preparation of urethanes, hydrogenations, condensations, oxidations, olefin insertions, oligomerizations of olefins, and addition reactions can be carried out in glymes as reaction medium.

Glymes are also useful as solubilizing agents, extractants and selective solvents.

Methoxyacetaldehyde dimethylacetal can be prepared by electrochemical oxidation in monoglyme. Aspartame was prepared by enzymatic catalysis in triglyme-water medium.

Polymerization and polymer modification

Catalysts of the Ziegler-Natta type for the polymerization of alpha-olefins are advantageously prepared as a slurry incorporating glymes. Glymes are additionally useful in removal of unreacted monomer in this type of polymerization. When diglyme is used to modify the Ti-Al-catalyzed preparation of a block ethylene-propylene copolymer, the physical properties of the copolymer are greatly improved.

Similarly, conjugated dienes can be polymerized in the presence of metal-based catalyst mixtures containing glymes.

Catalyst solutions for other types of polymerization advantageously use glymes. Monomers polymerized in the presence of glymes include cyclosiloxanes, conjugated alkadiene, lactams, dicyclopentadiene, vinyl chloride, fluorinated acrylic esters and 1-octene. Glymes are also useful in formulating storage-stable vulcanizing agents for urethane rubber.

Polyethylene terephthalate (PET) and its copolymers are produced with improved properties by incorporating glymes into the finished product.

Glymes are useful in formulating rigid polyurethane foams with improved fluidity during molding and with improved bonding strength. The viscosity of polyols useful in the manufacture of polyurethanes can be reduced by means of glymes without adversely affecting physical properties.

Polyurethane coatings used to form pinhole-free films with good adhesive strength, applicable to electrical and electronic parts, utilize glymes. Isocyanates are processed and formulated using glymes to yield isocyanurate and polyisocyanate prepolymers used in various polyurethane applications.

Polyglyme for gas scrubbing

The solvating ability of BASF's higher glymes, particularly polyglyme, for acid gases, together with their chemical stability, makes them useful in a wide variety of applications for gas purification. Polyglyme shows high selectivity for hydrogen sulfide over carbon dioxide and acts as a physical solvent where the gas loading is directly proportional to the partial pressure.

Especially BASF Polyglyme has been used in the field for more than 20 years.

Operating conditions

- Moderate to high pressure
- Ambient to 50C
- High to low acid-gas and moisture levels
- High gas flow rates

Operating costs

- Low polyglyme cost due to chemical stability and low losses due to high boiling point
- Carbon steel for most equipment

Characteristics

- High boiling point
- Strong solvency
- VOC reduction in formulations
- Drop-in for gas plants possible in many cases

Physical properties

Polyglyme empirical formula		$C_nH_{2n+2}O_{n/2}$
Molecular weight	[g/ml]	236 (275 avail)
Boiling point	[C] (760 mmHg)	275
Freezing point	[C]	–28
Density	[g/ml] (20C)	1.03
Vapor pressure	[hPa] (20C)	0.01
Viscosity	[mPa·s] (20C)	7.43
Auto ignition temp.	[C]	215
Flash point	[20C] (closed up)	156
Refractive index	[20C]	1.38
Appearance		clear, slight yellow

Relative solubility of acid gas in polyglyme

Methane	1.0
CO_2	15
H_2S	137
SO_2	1400
Water	11,00

Miscellaneous applications of glymes

Refrigeration – lubricate and increase efficiency

Tetraglyme is used to increase the efficiency of refrigeration systems while also serving as a lubricant due to its unique solvency parameters.

Tetraglyme was shown to have the best solubility in fluorocarbons in extensive work at GM. Tetraglyme showed high solubility for HFC-134a and newer chlorofluoro-carbons with negative deviations of the pressure vs. mole fraction data from Raoult's law. HFC-134a had lower solubilities in the other glycols or monoethers tested. Tetraglyme is also more chemically and thermally stable, in addition to having higher solvency for HFC-134a and similar refrigerants.

- The affinity of tetraglyme and HFC-134a was shown by an exothermic heat of mixing of –770 cal/mol at an 0.61 HFC-134a mol fraction.

Gold refining

Butyl diglyme is a selective solvent for the extraction of gold from hydrochloric acid solutions containing other metals. Treatment of the extract with a reducing agent such as oxalic acid reduces the trivalent gold to gold powder.

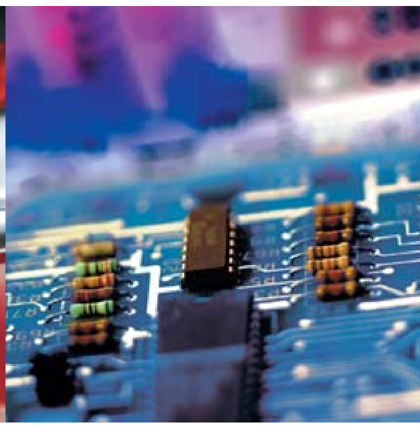
Films and adhesives

The higher glymes are powerful solvents for many polymer systems and find a role in many coating applications, including one and two-component polyurethanes and epoxies. Adhesive compositions based on alpha-cyanoacrylates show decreased setting times when glymes are incorporated into the formulation.

Textile processing

Polyester fibers with improved moisture retain are manufactured by incorporating 7 to 15% of a polyglyme into the poly(ethylene terephthalate), melt spinning the fibers, followed by washing to remove the polyglyme.

Synthetic fibers for sportswear having a high drying rate are made from a composition of poly(ethylene terephthalate) copolymers based on terephthalic acid and 10% polyglyme which is melt spun. The polyglyme is then extracted to produce the multiporous hydroscopic fibers.



Electronic chips, circuit boards and components

Glymes are useful solvents for the electronics industry due to their unique solvency properties. Glymes have the following benefits:

- Are easily removed via evaporation due to a strong complex with metal ions
- Are easily removed via evaporation due to aprotic nature and no hydroxyl groups to stick to surface
- Can be blended with other solvents to slow evaporation and metal ion removal
- Increase yield of your product: Less surface defects such as metal ions or organics on silicon
- Are stable to acid and base below 40C

Cleaning

The need for ever-better cleaners has been a driving force behind the evolution of surfactants. Monoethers were a major improvement over alcohols, esters, ketones, and other non-ionic surfactants.

Higher glymes have applications in fabric cleaning compounds, such as a dry powder carpet cleaner, in all-purpose liquid detergent compositions, in noncaustic alkaline, water-based oven cleaners and in bathroom mildew removers. They are useful in liquid stain removers for contact lenses, in compositions for wall paper and paint removal, in cleaners for rubber-based marking on tire sidewalls and in cleansers for removal of biological materials from laboratory diagnostic equipment.

Semipermeable membranes used in water purification are regenerated by washing with glyme. Fouled anion exchange resins are cleaned using higher glymes.

Glymes are useful as priming agents for removal of surface water from parts and in compositions for removal of rust-inhibiting oil coatings. Glymes are also useful in compositions used in cleaning felts for papermaking.

Glymes have the following high-performance properties:

- Dissolve polar and non-polar contaminants
- Very low odor compared to esters, ketones and monoethers
- Choice of boiling point
  - Fully compatible with quats
  - Compatible with hydrocarbons AND water!
  - Run cleaning hot or cold and match requirements for solvent recovery
- Use of higlyme (non-VOC) for heavy-duty water-based cleaning solutions
- Optimized cleaning by using dimethyl glymes for more polar impurities
- Use of butyl diglyme for non-polar impurities and high temperature
- Maintain ability to remove metal ions
- Reduce surface tension

1,3-Dioxolane

A powerful aprotic solvent

Dioxolane is a powerful aprotic solvent for use in formulations, in production processes or even as a reactant. Dioxolane has a very good toxicity profile.

Many applications of dioxolane are due to its ability to rapidly dissolve polar polymers, such as polyesters, epoxies and urethanes. Its small size allows it to rapidly penetrate the polymer, resulting in rapid application rates for various coating processes. Its low boiling point helps achieve high throughput or fast drying.

Dioxolane is also an essential ingredient in important industrial polymers and certain niche pharmaceutical intermediates.

Whether as a solvent or reagent, whether for new or existing applications, BASF dioxolane meets rigid standards set for industries that cannot tolerate impurities. The physical, chemical and applications information contained in this brochure can help you decide whether BASF‘s high purity grade of dioxolane meets your requirements.

1,4-Dioxane

An aprotic cyclic diether with active solvency

1,4-Dioxane is an aprotic solvent. It is relatively inert under various conditions with outstanding stability at high pH. The moderate boiling point allows for easy separation and recovery from reaction mixtures. BASF offers the highest purity (99.95%) and low moisture (100 ppm max).

Process solvent

- For etching of teflon and fluoropolymers with alkali metal dispersions
- Effective solvent for pharmaceutical and fine chemical synthesis
- Electrolyte solutions

Reaction solvent

- For the manufacture of drugs and APIs
- For organometallic reactions, including Grignard reactions
- For the manufacture of protease inhibitors (anti-AIDS drugs)
- Acting as a polycarbonate swelling agent
- Activator for metal borohydrides

Properties

- Aprotic
- Moderate boiling point
- Water-soluble
- High solvency characteristics
- Powerful diluent
- Excellent thermal and chemical stability

Please refer to MSDS for toxicological properties, detailed handling and disposal information.

Technical data

Glymes: physical and thermodynamic properties

	Empirical formula	Mol. weight [g/mol]	Boiling point [C] (1,010.8 hPa)	Free-zing point [C]	Density [g/ml] (20C)	Weight per gallon [lb] (20C)	Vapor pressure [hPa] (20C)	Evap. rate (n-Butyl acetate = 1)	Viscosity [mPa·s] (20C)	Surface tension [mN/M] (20C)	Specific heat J/g·k
Monoglyme	$C_4H_{10}O_2$	90.1	84.45	–58	0.86	0.87	71.91	4.99	0.47	20.51	2.15
Ethyl glyme	$C_6H_{14}O_2$	118.2	120.6	–74	0.84	7.00	13.02	1.05	0.73	24.3	2.16
Diglyme	$C_6H_{14}O_3$	134.2	160.16	–64.04	0.95	7.88	2.15	0.36	1.06	31.1	2.04
Ethyl Diglyme	$C_8H_{18}O_3$	162.2	188.9	–44.3	0.91	7.56	0.51	0.04	1.38	27.39	2.07
Triglyme	$C_8H_{18}O_4$	178.2	216.25	–43.8	0.99	8.23	0.03	< 0.001	3.39	29.02	2.06
Butyl Diglyme	$C_{12}H_{26}O_3$	218.3	251.31	–60.2	0.89	7.36	0.03	< 0.001	2.3	26.91	1.95
Tetraglyme	$C_{10}H_{22}O_5$	222.3	276.49	–29.7	1.01	8.45	< 0.01	< 0.001	4.01	33.96	2.07
Polyglyme*	$C_nH_{2n+2}O_{n/2}$	275	275	–28.0	1.03	8.6	< 0.01	< 0.001	7.43	35.6 (25C)	2.28
Proglyme	$C_8H_{18}O_3$	162.2	175	–75	0.9	750	23.16 (65C)	0.13	0.99	26.8	2.03 (39.4C)
Higlyme	$C_nH_{n+2}O_x$	> 400	275	–5 – 10	0.98	8.12	< 0.01	< 0.001	34	36.0	2.01 est.

* Mixture of high molecular weight glymes. 235 MW polyglyme is also available.
** Not determined

Auto Ignition temp [C]	Heat of vaporiza-tion [kJ/mol]	Heat of combus-tion [kJ/mol]	Heat of forma-tion [kJ/mol]	Flash point [C] (closed up)	EU VOC status	Appearance	Odor	Solubility at 25C		
								In water	Water in	Organics
205	226.82	2,522.38	494.42	2	VOC	Clear Colorless	Ethereal Non-residual	Complete	Complete	All glymes are miscible in all proportions in ethanol, acetone, benzene, diethylether, and octane.
175		4,005.64		19	VOC	Clear Colorless	Mild ethereal Non-residual	20.4%	3.3%	
190	41.9	3,779.38	599.17	51	VOC	Clear Colorless	Mild ethereal Non-residual	Complete	Complete	
205	51.45	5,023.81	636.88	67	VOC	Clear Colorless	Mild Non-residual	Complete	Complete	
195	59.92	4,990.29	750.01	111	VOC	Clear Colorless	Mild Non-residual	Complete	Complete	
190	50.28	7,638.37	733.25	118	non-VOC	Clear Colorless	Very mild Non-residual	0.3%	1.4%	
200	78.35	6,201.2	909.23	141	non-VOC	Clear Colorless	Very mild Non-residual	Complete	Complete	
215		6,201.2 est.	963.7 est.	156	non-VOC	Clear, slightly yellow	Very mild Non-residual	Complete	Complete	
156	41.9	4,705.37		65	VOC	Clear Colorless	Very mild	35	4.5	
ND**		9,218 est.	1,257 est.	> 140	non-VOC	Clear, slightly yellow	Very mild Non-residual	Complete	Complete	

1,3-Dioxolane and 1,4-Dioxane: physical property comparison

	Diethyl ether	Methylene chloride	Tetrahydro-furan	1,1,1-Trichlo-roethane	1,3-Dioxolane	Methyl ethyl ketone	Ethylene dichloride	1,4-Dioxane	Toluene
MW [g/mol]	74.1	84.9	72.1	133	74.1	72.1	99	88.1	92.1
BP [C]	34.5	39.67	65.98	74.07	76.35	79.51	83.57	101.3	110.7
Vapor pressure [hPa] (20C)	585.2	475.67	171.7	131.95	107.16	95.08	82.59	37.88	29.22
Freezing point [C]	–116.3	–95.14	–108.5	–30.05	–95	–86.67	–35.66	11.8	–94.97
Flash point [C]	–40	None	0.48	None	–5	–6	13	11	6
Density [g/ml] (20C)	0.71	1.33	0.89	1.34	1.06	0.8	1.25	1.03	0.87
Viscosity [mPa·s] (25C)	0.23	0.41	0.48	0.77	0.59	0.39	0.78	1.19	0.55
Dielectric constant	4	8.9	7.5	7.58	7.13	18.5	10.4	2.2	2.38
Dipole moment (Debye)	1.15	1.6	1.63	1.87	1.5	3.3	1.8	0.4	0.4
Specific heat [J/g·K]	2.34	1.19	1.7	1.08	1.64	2.19	1.3	1.74	1.69
Heat of vapor [J/g]	367.26	344.57	444.51	243.68	502	481.43	358.52	455.48	412.89
Evap. rate (n-butyl acetate = 1)	11.8	14.5	8	6.0	3.5	3.8	5.1	2.2	1.9
Solubility, H_2O in, %	1.3	0.14	100	0.04	100	27.3	0.18	100	0.05
Solubility, in H_2O, %	6.5	1.32	100	0.13	100	12.1	0.95	100	0.05
Solubility parameter, $(J/cm^3)^{1/2}$	15.4	20.37	18.97	17.25	42.74	18.88	20.26	20.54	18.25
Hydrogen bonding group	M	P	M	P	M	M	P	M	P

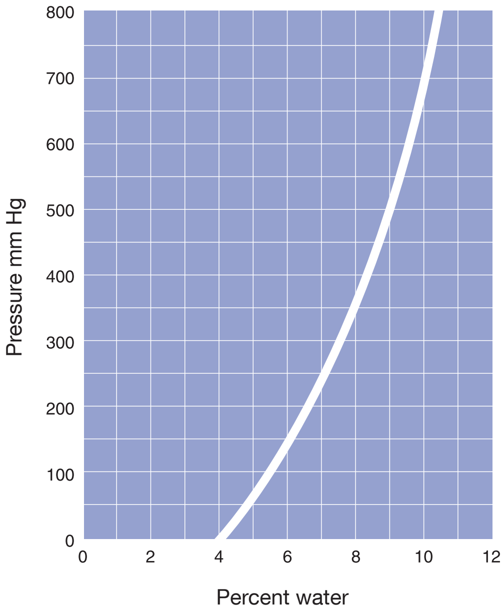
High-performance solvents: specifications

	Purity [wt%] (by GC)		Acidity [ppm acetic acid]		Water [ppm]		Peroxide [ppm]	
	Min	Typical	Max	Typical	Max	Typical	Max	Typical
Monoglyme	99.9	99.97	150	25	350	175	15	5
Ethyl glyme	97.0	97.0	150	25	1000	300	15	5
Diglyme	99.9	99.85	150	25	250	150	15	5
Ethyl diglyme	98.0	97.7	150	25	2000	500	15	5
Triglyme	98.0	98.5	150	25	500	100	15	5
Butyl diglyme	98.5	99.6	100	25	500	250	15	5
Tetraglyme	98.0	99.0	150	25	500	100	15	5
Proglyme	99.2	99.3	100	25	200	100	15	5
Higlyme	97.0	98.0	150	25	2000	600	15	5
1,3-Dioxolane	99.9	99.9	100	50*	150	100	5	3
1,4-Dioxane	99.95	99.5	50	25	100	80	5	3

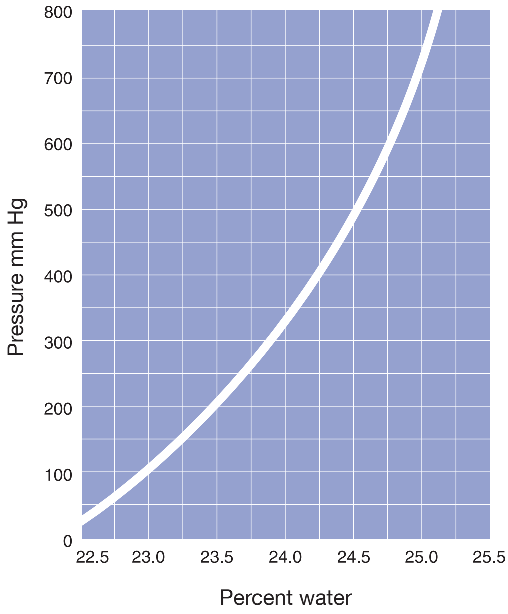
**As formic acid*

Glymes: azeotropic data

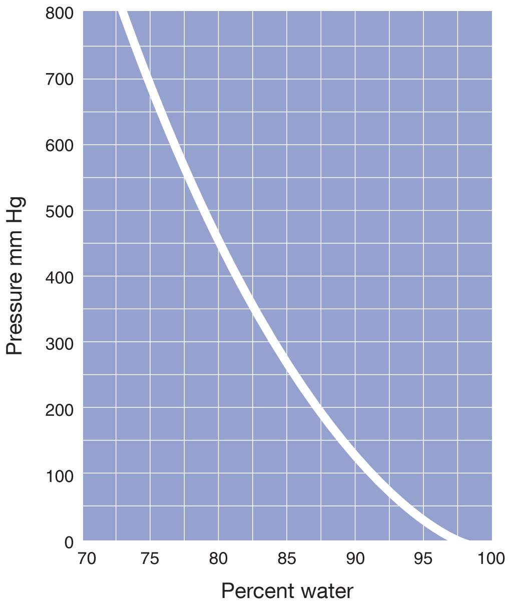
Monoglyme
Boiling point at 760 mm Hg –76C
100 mm Hg –30C



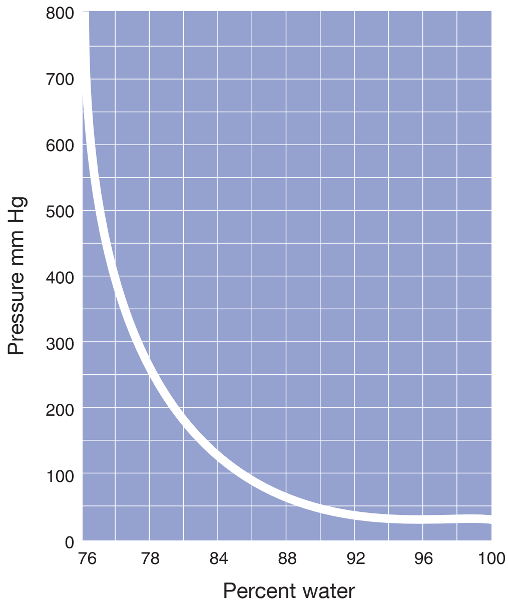
Ethyl glyme
Boiling point at 760 mm Hg –90C
100 mm Hg –46C



Diglyme
Boiling point at 760 mm Hg –99.5C
100 mm Hg –54C

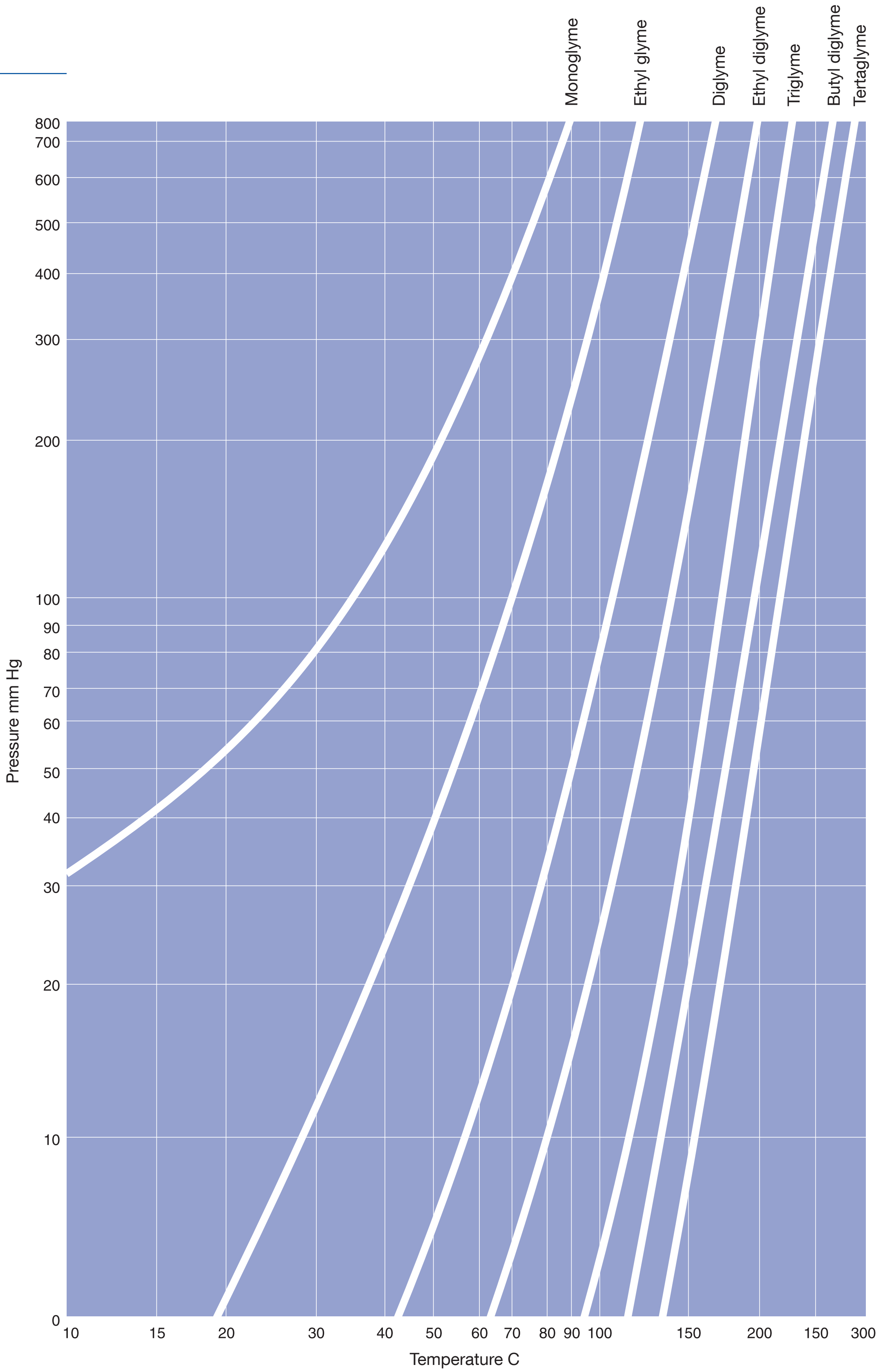


Ethyl glyme
Boiling point at 760 mm Hg –98C
100 mm Hg –54C



**Butyl Diglyme, Triglyme, and Tetraglyme do not form azeotropes with water.*

Vapor pressure temperature relationships



Polymer solubility

The solubility of various plastic and elastomeric materials in glymes was determined by placing 10 grams of sample in 100 ml of the glyme at 21C. The samples were examined after one week.

	1,3-Dioxolane	Monoglyme	Diglyme	Ethyl diglyme	Butyl diglyme	Tetraglyme
Plastics, Acrylate						
Acrylate ester	S	S	S			S
Polymethyl methacrylate	S	S	S			S
Vinyl						
Polyvinyl acetate	S	S	S			S
Polyvinyl chloride	A	A	A	A	U	A
Chlorinated polyvinyl chloride	A		S	A	U	
Polyvinyl chloride acetate	S	A	A	S	A	A
Polyvinyl alcohol	A	U	U	U	U	U
Polyvinylidene chloride	U	U	A	U	U	A
Cellulose						
Cellulose acetate	S	S	S			S
Cellulose acetate butyrate	S	S	S	A	U	S
Cellulose nitrate	S	S	S			S
Methyl cellulose	S	S	S	A	U	S
Condensation polymers						
Phenol formaldehyde, cast	A	A	A			A
Nylon	A	U	U	U	U	U
Polyester	A	U	U	U	U	U
Polyurethane	A	A	S	A	U	S
Polycarbonate	A	A	A	A	U	A
Epoxy resins	S	S	S	S	S	S
Other polymers						
Polyethylene	U	U	U	U	U	U
Polystyrene	A	A	A			A
Polytetrafluoroethylene	U	U	U	U	U	U
Elastomers						
Neoprene	S	S	S	S	S	S
EVA	A	A	A	A	A	U
Nitrile rubber (NBR)	S	S	S	S	A	S
Natural rubber	S	S	A	S	S	A
EPDM	A	U	U	A	A	A
SBR	S	S	S	S	S	A

U–Unaffected*
A–Attacked (noticeable softening; some swelling)
S–Soluble (10% or more; extreme swelling to gelation)

**Because of variability of polymer types and grades, user should evaluate materials for each specific application.*

Handling recommendations

General handling

Since glymes are powerful solvents for many polymers, selecting materials that may contact glymes in a process can be difficult. Teflon is highly resistant, and substances such as butyl rubber, polyethylene and polypropylene can be used in many applications. Resistance to glymes is improved when the molecular weight of the polymers used is high or there is a high degree of crosslinking or crystallinity. Specific applications should be tested for polymer swell, softening, degradation and permeability.

Carbon steel can be used for storing and handling pure glymes. We recommend storage in an inert atmosphere such as nitrogen to assure product purity for a prolonged period. In this way, both oxygen and atmospheric moisture can be avoided.

Glymes are biodegradable in conditioned waste biotreatment units. However, it appears that biodegradation is slow and conversion may be low in normal sewerage systems.

Recovery and recycling

Each application of glycol diethers may produce unique problems with recovery and recycling processes. In general, the lower molecular weight glymes are recovered most efficiently by distillation. Water azeotrope, however, may complicate the process. Contact with sodium hydroxide is effective in removing gross amounts of water. Trace amounts can be effectively removed by molecular sieves to a very low level.

BASF can provide technical information to help customers develop a safe and cost-effective recycling program. In some cases, BASF can also provide final “back-to-spec” purification services if needed. Please contact a service representative if you need this type of service.

Toxicity of lower glymes

Monoglyme, diglyme and ethyl glyme are only suitable for use in enclosed applications such as reaction solvents as they are recognized reproductive toxins. Higher glymes, such as ethyl diglyme, butyl diglyme, tetraglyme, polyglyme and higlyme have lower acute and reproductive toxicity and are considered suitable for use in emissive applications.

Peroxides

High-purity standards are maintained by a number of rigid manufacturing controls. The glymes and dioxolane are manufactured in a dry, inert environment and packaged under nitrogen. This assures product integrity over long periods of storage. Our studies show that the peroxide concentration remains barely detectable (in the ppm range) even after storage periods as long as a year.

Peroxides in ethers can decompose to form other impurities. However, unlike ethers such as THF and ethyl ether where peroxides accumulate rapidly, glycol diether peroxides are much more labile and tend not to build to high levels. Safe decomposition of glyme peroxides can be accelerated simply by warming the glyme under nitrogen to 90C for a brief period.

In many instances where 1,3-dioxolane and 1,4-dioxane are used, air exposure cannot be avoided. In this case, peroxide concentration should be monitored and controlled. Even though this may not represent a safety-related problem (except for a flammability hazard), the peroxides might form undesirable chemical by-products in the system.

With some chemicals there is a tendency for peroxides to become isolated by phase separation, which results in the formation of a zone of high peroxide concentration. This phenomenon is unlikely in glymes because of the very high solubility of peroxides and other oxygenated organic material in glymes. Peroxide formation can be effectively stopped by using a phenolic antioxidant such as BHT. At the customer's request BHT can be added to any glyme order.

To the best of our knowledge, there has never been an incident of an explosion due to peroxide buildup in glymes. We do, however, recommend that the highest standards of safety, product stewardship and responsible care be maintained when using and recycling glymes. Never distill to dryness when using or recycling any oxygen-containing solvent.

For safety data, please refer to the material safety data sheet.

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