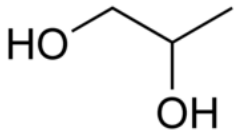
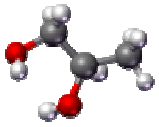
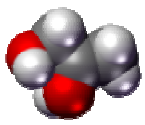
THE BASIC CHEMISTRY
OF
GLYCOL FOOD GRADE HYDRAULIC FLUIDS

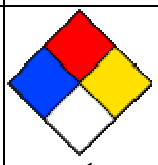
All propylene glycol hydraulic fluids are formulated from three basic components; propylene glycol plus thickeners, high purity de-ionized water, and amine additives. The proportions of the basic components differ from one fluid to another and from one manufacturer to another. Each component provides separate functions, which when blended, create a fluid capable of performing as a superior hydraulic lubricant. The true difference in the fluids comes from the additive amine package. These additive packages are kept proprietary from one manufacturer to the next. This document has not been drafted to deal with the specifics of the propylene glycol fluids that MRL Hydraulics LLC provides, but has been drafted for general information only.

Propylene glycol hydraulic fluids are used primarily as fire-resistant fluids in the food processing industry. Since they have low toxicity they have been deemed appropriately safe for incidental food contact by the National Sanitation Foundation (NSF). Propylene Glycol Water Based hydraulic fluids provide superior performance lifetimes when compared to vegetable based hydraulic fluids which tend to have much higher oxidation rates.

Propylene glycol

From Wikipedia, the free encyclopedia

Propylene glycol			
			
			
IUPAS name	propane-1,2-diol	Solubility in water	fully miscible
Other names	propylene glycol	Solubility in ethanol	fully miscible
Identifiers		Solubility in diethyl ether	fully miscible
CAS number	57-55-6	Solubility in acetone	fully miscible
TTECS number	TY6300000	Solubility in chloroform	fully miscible
SMILES	CC(O)CO	Thermal conductivity	0.34 W/m-K (50% H2O @ 90°C

Properties		Hazards	
Molecular formula	$C_3H_8O_2$	MSDS	External MSDS
Molar mass	76.09 g/mol	NFPA 704	 1 0 0
Density	1.036 g/cm³	S-phrases	S 24 S 25
Melting point	-59 °C		
Boiling point	188.2 °C		
Related compounds			
Related glycols	**Ethylene glycol**		
Except where noted otherwise, data are given for materials in their standard state (at 25° C, 100 kPa)			

Propylene glycol, known also by the systematic name propane-1,2-diol, is an organic compound (a diol alcohol), usually a tasteless, odorless, and colorless clear oily liquid that is hydroscopic and miscible with water, acetone, and chloroform.

Chirality

Propylene glycol contains an asymmetrical carbon atom, so it exists in two isomers. The commercial product is a racemic mixture. Pure optical isomers can be obtained by hydration of optically pure propylene oxide. [1]

Production

Industrially propylene glycol is produced by propylene oxide hydration. Different manufacturers use non-catalytic high-temperature process or catalytic route with acid or alkali as a catalyst. Propylene glycol can also be converted from glycerol, a biodiesel byproduct.

Applications

Propylene glycol is used:

- **As a moisturizer in medicines, cosmetics, food, toothpaste, mouth wash, and tobacco products**
- **As a medical and sexual lubricant (A.K.A. "personal lubricant ")**
- **As an emulsification agent in Angostura and Orange bitters**
- **As a solvent for food colors and flavourings**
- **As a humectant food additive, labeled as E number E1520**
- **As a carrier in fragrance oils**
- **As a less-toxic antifreeze**
- **In smoke machines to make artificial smoke for use in firefighters' ' training and theatrical productions**
- **In electronic cigarettes to make the produced vapor better resemble cigarette smoke**
- **In hand sanitizers, antibacterial lotions, and saline solutions**
- **In cryonics**
- **As a working fluid in hydraulic presses**
- **To regulate humidity in a cigar humidor**
- **As the killing and preserving agent in pitfall traps, usually used to capture ground beetles**
- **To treat livestock ketosis**

Propylene glycol has similar properties as ethylene glycol (MEG). The industrial norm is to replace ethylene glycol by propylene glycol.

Safety

Cases of propylene glycol poisoning are related to either inappropriate intravenous use or accidental ingestion by children. [2] The oral toxicity of propylene glycol is very low. In one study, rats were provided with feed containing as much as 5% PG over a period of 104 weeks and they showed no apparent ill effects.[3] Because of its low chronic oral toxicity, propylene glycol is generally recognized as safe (GRAS) for use as a direct food additive.

Serious toxicity will occur only at extremely high intakes over a relatively short period of time that result in plasma concentrations of over 4 g/L. [4] Such levels of ingestion would not be possible when consuming reasonable amounts of a food product or dietary supplements containing *at most* 1 g/kg foodstuff.

The U.S. Food and Drug Administration (FDA) has determined propylene glycol to be "generally recognized as safe" for use in food, cosmetics, and medicines. Like ethylene glycol, propylene glycol affects the body's chemistry by increasing the amount of acid. Propylene glycol is metabolized into lactic acid, which occurs naturally as muscles are exercised, while ethylene glycol is metabolized into oxalic acid, which is toxic.

However, propylene glycol is not approved for use in cat food. The U.S. Food and Drug Administration has determined that propylene glycol in or on cat food has not been shown by adequate scientific data to be safe for use. Use of propylene glycol in or on cat food causes the feed to be adulterated and in violation of the Federal Food, Drug, and Cosmetic Act. 21CFR589.1001

Prolonged contact with propylene glycol is essentially non-irritating to the skin. Undiluted propylene glycol is minimally irritating to the eye, and can produce slight transient conjunctivitis (the eye recovers after the exposure is removed). Exposure to mists may cause eye irritation, as well as upper respiratory tract irritation. [5] Inhalation of the propylene glycol vapors appears to present no significant hazard in

ordinary applications. However, limited human experience indicates that inhalation of propylene glycol mists could be irritating to some individuals. Therefore inhalation exposure to mists of these materials should be avoided. Some research has suggested that propylene glycol not be used in applications where inhalation exposure or human eye contact with the spray mists of these materials is likely, such as fogs for theatrical productions or antifreeze solutions for emergency eye wash stations. [6]

Propylene Glycol does not cause sensitization and it shows no evidence of being a carcinogen or of being gentoxic.[7][8]

Post menopausal women who require the use of an estrogen cream may notice that brand name creams made with propylene glycol often create extreme, uncomfortable burning along the vulva and perianal area. In these cases, patients can request that a local compounding pharmacy make a "propylene glycol free" cream which is much more tolerable.

Research has suggested that individuals who cannot tolerate propylene glycol probably experience a special form of irritation, but that they only rarely develop allergic contact dermatitis. Other investigators believe that the incidence of allergic contact dermatitis to propylene glycol may be greater than 2% in patients with eczema.[9]

Patients with vulvodynia and interstitial cystitis may be especially sensitive to propylene glycol. Women struggling with yeast infections may also notice that some OTC creams can cause intense burning. [10]

References

1. ^ 1,2-Propanediol. ChemIndustry.ru. Retrieved on 2007-12-28.
2. ^ National Library of Medicine;. Human Toxicity Excerpts: CAS Registry Number: 57-55-6 (1,2-Propylene Glycol). Selected toxicity information from HSDB.. 2005.
3. ^ Gaunt, IF, Carpanini, FMB, Grasso, P and Lansdown, ABG, Long-term toxicity of propylene glycol in rats, Food and Cosmetics Toxicology, Apr. 1972, 10(2), pages 151 - 162.
4. ^ Flanagan RJ; Braithwaite RA;Brown SS;Widdop B;de Wolff FA;. The International Programme on Chemical Safety: Basic Analytical Toxicology. WHO, 1995.
5. ^ Dow Propylene Glycol Industrial Safety Data Sheet (http://www.dow.com/PublishedLiterature/dh_0361/09002f1380361176.pdf?filepath=propyleneglycol/pdfs/noreg/117-01515.pdf&fromPage=GetDoc), No. 248, November 17, 2003, page 1.
6. ^ A Guide to Glycols (http://www.dow.com/PublishedLiterature/dh_02aa/09002f13802aaf25.pdf), page 36.
7. ^ 1,2-Dihydroxypropane SIDS Initial Assessment Profile (http://www.chem.unep.ch/irptc/sids/OECDSIDS/57-55-6.pdf), UNEP Publications, SIAM 11, U.S.A, January 23-26, 2001, page 21.
8. ^ Title 21, U.S. Code of Federal Regulations. 1999.
9. ^ [American Medical Association, Council on Drugs. AMA Drug Evaluations Annual 1994. Chicago, IL: American Medical Association, 1994., p. 1224]
10. ^ Elizabeth Vliet MD, Screaming To Be Heard: Hormonal Connections That Women Suspect and Doctors Ignore". M. Evans and Company, Inc. New York 1995

- *Merck Index*, 11th Edition, 7868

DEIONIZED/DE-IONIZED WATER

In general deionized water is water that has been stripped of all ions rendering it ultra pure for use in chemical blending. Water as it's used in water glycol hydraulic fluids is utilized as a way of controlling the viscosity of the fluid and renders the fluid fire resistant. For the fluid to support combustion all of the water must be boiled off first. Water constitutes from 35% to 60% of the fluid.

Deionized water (DI water or de-ionized water); also spelled deionised water, is water that lacks ions, such as cations from sodium, calcium, iron, copper and anions such as chloride and bromide. This means it has been purified from all other ions except H_3O^+ and OH^-, but it may still contain other non-ionic types of impurities such as organic compounds. This type of water is produced using an ion exchange process. Deionized water is similar to distilled water, in that it is useful for scientific experiments where the presence of impurities may be undesirable.

Properties

The lack of ions causes the water's resistivity to increase. Ultra-pure deionized water can have a theoretical maximum resistivity up to 18.31 MΩ·cm, compared to around 15 kΩ·cm for common tap water. Deionized water's high resistivity allows it, in some very highly specialized instances, to be used as a coolant in direct contact with high-voltage electrical equipment. Because of its high relative dielectic constant (~80), it is also used (for short durations) as a high voltage dielectric in many pulsed power applications, such as Sandia's Z Machine.

pH values

The pH is a logarithmic measurement of proton presence; the true pH of deionized water is 7.0, because the ionization constant of water (K_w) ~ 10^{-14}, so $p[K_w] = 14$, and $pH + pOH = p[K_w]$

In practice, the indication from chemical indicators can give a value of usually between pH 5.0 and pH 9.0 depending on the indicator used (the indication being the ions introduced by the indicator itself, its solvent and its impurities). Electronic pH meters will output an unpredictable value since the absence of ions in the liquid means that the two parts of the electrode are insulated from each other and thus would generate no EMF. In practice since absolutely pure water is an unattainable goal, the liquid will contain a very small amount of ions, but the current this would allow the probe to generate will be far smaller than that required to operate the metering circuit.

Electrodes of a pH meter should not be immersed in deionised water for prolonged periods as the lack of any ions 'sucks' them out of the electrode degrading its performance. Deionised water should be used for cleaning only rarely as the effect is cumulative. Electrodes should be cleaned using proper cleaning solution (usually very acidic), and rinsed between samples; ideally it should be rinsed using an extract from the next sample to be tested, but failing that, a pH neutral liquid such as tap water or pH 7.0 buffer solution is suitable.

Deionized water will quickly acquire a pH when exposed to air. Carbon dioxide, present in the atmosphere, will dissolve in the water, introducing ions and giving an acidic pH of around 5.0. The limited buffering capacity of DI water will not inhibit the formation of carbonic acid H_2CO_3. Boiling the water will remove the carbon dioxide to restore the pH to 7.0.

Ultrapure deionized water

The uses of ultrapure deionized water are many and varied, often having applications in scientific experimentation such as when very pure chemical reagent solutions are needed in a chemical reaction or when a biological growth medium needs to be sterile and very pure. Laboratory grade ultra pure water cannot be stored in glass or plastic containers because such materials leach contaminants at very low

concentrations into the water. Storage vessels made of silica are used for less demanding applications but for highest purity uses, containers made from ultra pure Tin are used.

Deionization

Process utilizing specially-manufactured ion exchange resins which remove ionized salts from water can theoretically remove 100% of salts. Deionization typically does not remove organics, virus or bacteria, except through "accidental" trapping in the resin and specially made strong base anion resins which will remove gram-negative bacteria.

AMINE ADDITIVES

Amines are organic compounds and a type of functional group that contain nitrogen as the key atom. In structure, amines resemble ammonia, wherein one or more hydrogen atoms are replaced by organic substiuents such as alkyl and aryl groups. An important exception to this rule is that compounds of the type $RC(O)NR_2$, where the C(O) refers to a carbonyl group, are called amides rather than amines. Amides and amines have different structures and properties, so the distinction is chemically important. Somewhat confusing is the fact that amines in which an N-H group has been replaced by an N-M group (M = metal) are also called amides. Thus $(CH_3)_2NLi$ is lithium dimethylamide.

Amines are central in organic chemistry. All known life processes depend on amino acids each of which contains an amine group.

Amines in the fluid blend are used to control lubricity and are base pH from 8.0 to 10.0. The amine additives range from 5% to 10% of the fluid. The additive package provides not only lubricity, but also anti-wear agents, anti-oxidation agents, anticorrosion agents and anti-foaming agents. The package is proprietary to the manufacturer and controlling the pH of the fluid is used to control the boundary layer lubrication film between the mating surfaces. In food grade water glycol hydraulic fluid the amine package is not as robust as in non-food grade water glycol hydraulic fluids. Therefore, the additive package wears more quickly requiring fluid change more often.

By regulation and industry standards food grade water glycols do not have colorization added and appear somewhat as a clear translucent fluid. In addition, dye detection systems are not allowed.