Technical Information

TERATHANE® POLYETHER GLYCOL

Properties, Uses, Storage and Handling of TERATHANE® PTMEG

Product Information

TERATHANE® PTMEG is a family of polyether glycols available in a range of molecular weights. They are liquid or a waxy, white solid that melts to a clear, colorless, viscous liquid over a wide temperature range near room temperature.

INVISTA markets PTMEG in seven molecular weights: TERATHANE® PTMEG 250, 650, 1000, 1400, 1800, 2000 and 2900.

TERATHANE® PTMEG is a blend of linear diols in which the hydroxyl groups are separated by repeating tetramethylene ether groups. For example, TERATHANE® PTMEG 1000 is $H(OCH_2CH_2CH_2CH_2)nOH$, where n averages 14 and for TERATHANE® PTMEG 2000, n averages about 27.

The Chemical Abstracts Service covers TERATHANE® PTMEG under two names: furan, tetrahydro, polymer (CAS Registry Number 24979-97-3) and poly(oxy-1,4-butanediyl)-a-hydro-w-hydroxy (CAS Registry Number 25190-06-1). The TSCA inventory lists only the latter number.

Physical Properties

The density coefficient of TERATHANE® PTMEG is 0.066 g/ml/100°C. It is readily soluble in alcohols, esters and ketones, but insoluble in aliphatic hydrocarbons. TERATHANE® PTMEG will dissolve in aromatic and chlorinated hydrocarbons, but is insoluble in water.

The solubility of TERATHANE® PTMEG in functional solvents decreases as the length of aliphatic chains increase; for example, TERATHANE® PTMEG is completely miscible with methanol, but insoluble in dodecanol. 1,4 BDO dissolves up to approximately 20wt% TERATHANE® PTMEG 1000 at 25°C (77°F), but less than 10wt% TERATHANE® PTMEG 2000 (see Fig 2).

TERATHANE® PTMEG is hygroscopic. At room temperature, it can absorb up to 2wt% water, depending on the molecular weight of the glycol. TERATHANE® PTMEG 250 is mostly miscible with water.

Chemical Reactions

TERATHANE® PTMEG is a dihydric alcohol and undergoes the reactions typical of the hydroxyl group. The two commercially significant reactions are esterification with carboxylic acids and formation of urethanes with isocyanates. Reaction with acrylic acids results in the addition of a vinyl group that can be subsequently cross-linked.

Stability

An approximate shelf-life of TERATHANE® PTMEG is two years if the product is stored in the original container at ambient temperature under a dry nitrogen blanket and tightly closed. Because storage and local ambient conditions vary and INVISTA has no control over the practices, procedures and conditions at a customer's facility, the shelf-life estimate provided should be used as guidance only. It is not provided as a guarantee of any shelf life.

Table 1: Standard Sales Specifications

Grade	TERATHANE® PTMEG 250	TERATHANE® PTMEG 650	TERATHANE® PTMEG 1000	TERATHANE® PTMEG 1400	TERATHANE® PTMEG 1800	TERATHANE® PTMEG 2000	TERATHANE® PTMEG 2900
Molecular Weight	230 – 270	625 – 675	950 – 1050	1350 – 1450	1700 – 1900	1900 – 2100	2825 – 2976
Hydroxyl Number, mg KOH/gm	415.6 – 487.8	166.2 – 179.5	106.9 – 118.1	77.4 – 83.1	59.1 – 66.0	53.4 – 59.1	37.7 – 39.7
Water, ppm	150 max	150 max	150 max	150 max	150 max	150 max	150 max
Color, APHA	40 max	50 max	40 max	40 max	40 max	40 max	40 max
Alkalinity Number, meq. KOH/kg x 30	-2.0 – 1.0	-2.0 – 1.0	-2.0 – 1.0	-2.0 – 1.0	-2.0 – 1.0	-2.0 – 1.0	-2.0 – 1.0

Stabilizer BHT: TERATHANE® PTMEG 250, 650, 1000, 1400, 2000: 200 - 350 ppm
TERATHANE® PTMEG 1800: 150 – 350 ppm
TERATHANE® PTMEG 2900: 300– 500 ppm

Table 2: Physical Data and Properties

Grade	TERATHANE® PTMEG 250	TERATHANE® PTMEG 650	TERATHANE® PTMEG 1000	TERATHANE® PTMEG 1400	TERATHANE® PTMEG 1800	TERATHANE® PTMEG 2000	TERATHANE® PTMEG 2900
Viscosity 40°C (104°F), cP	40 – 80	100 – 200	260 – 320	480 - 700	850 - 1050	950 – 1450	3200 – 4200
Melting Point °C °F	-5 – 0 23 – 32	11 – 19 52 – 66	25 – 33 77 – 91	27 – 35 81 – 95	27 – 38 81 – 100	28 – 40 82 – 104	30 – 43 86 – 109
Density 40°C (104°F), g/mL lb/gal	0.98 8.2	0.98 8.2	0.97 8.1	0.97 8.1	0.97 8.1	0.97 8.1	0.97 8.1
Refractive Index, n_D^{25}	1.464	1.464	1.464	1.464	1.464	1.464	1.464
Flash Point Tag °C, °C °F	> 163 > 325	> 163 > 325	> 163 > 325	> 163 > 325	> 163 > 325	> 163 > 325	> 163 > 325
Peroxide Content, ppm as H_2O_2	< 5	< 5	< 5	< 5	< 5	< 5	< 10

Figure 1: Approximate Viscosity as a function of Temperature and by Grade

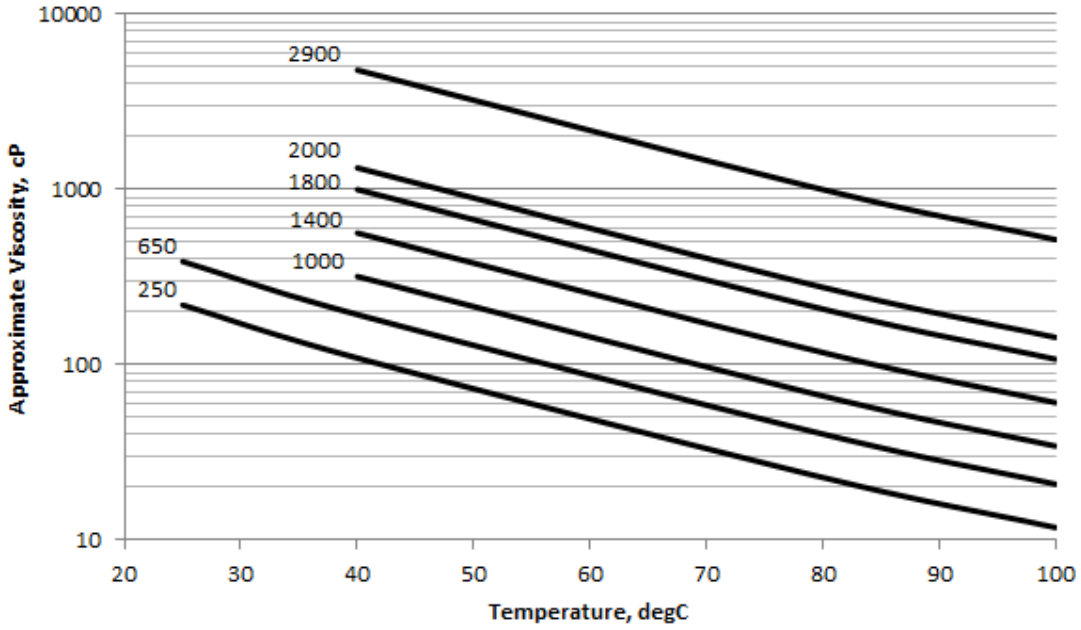
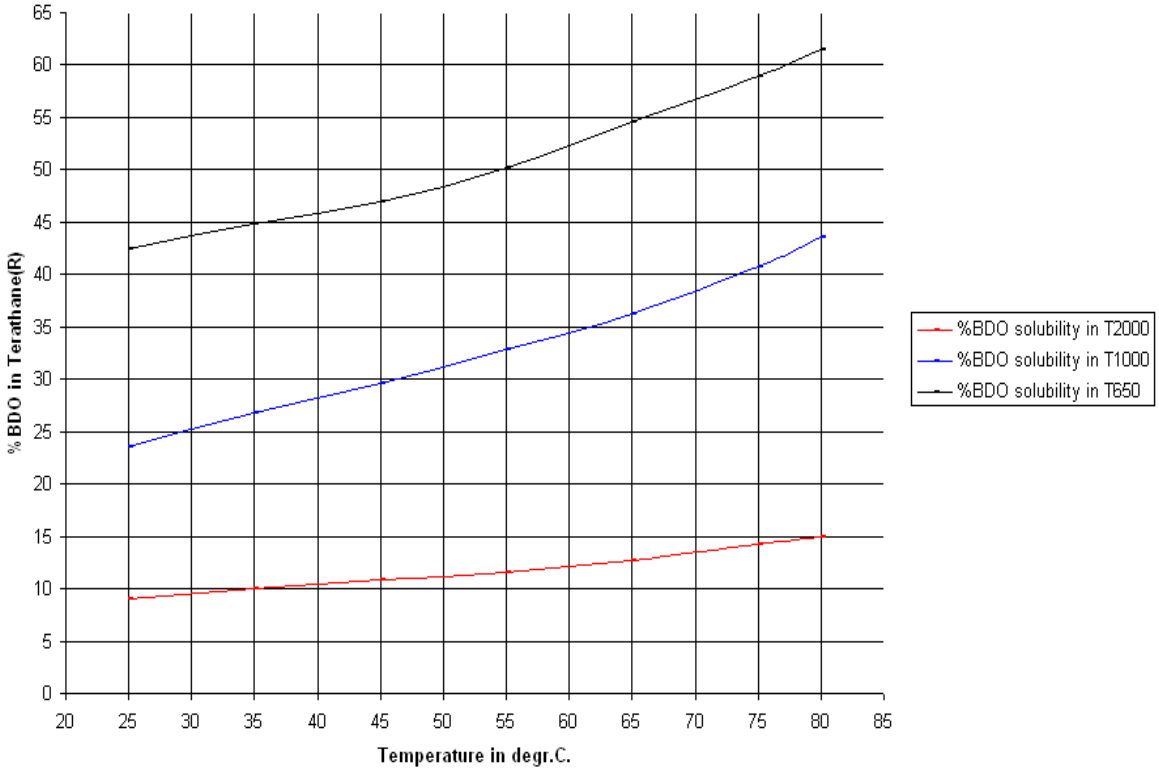


Figure 2: 1,4 BDO Solubility in TERATHANE® PTMEG



Shipping Containers

TERATHANE® PTMEG is available in railcars, tank trucks, ISO containers, or 55-gal (441lb/200kg net) steel drums.

TERATHANE® PTMEG is not regulated as a hazardous material by the Department of Transportation (DOT), IMO or IATA as of July 2015[1].

Personal Safety and First Aid Health Hazards

For safety, first aid and health hazards, please refer to the Safety Data Sheet.

FDA Status

Terathane® PTMEG is comprised of alpha-hydro-omegahydroxypoly-(oxytetramethylene) (CAS # 25190-06-1) with 150-500 ppm of 2,6-di-tert-butyl-p-cresol (BHT, Butylated hydroxytoluene, CAS# 128-37-0) as an antioxidant.

In the United States, BHT is listed as generally recognized as safe (GRAS) for use in food in 21 C.F.R. §182.3173. Pursuant to 21 C.F.R. § 174.5, substances that are GRAS for direct addition to food can also be used in food-contact applications.

As to PTMEG, FDA's regulations clear several polymers produced from PTMEG for use in food contact applications in the following sections of the Code of Federal Regulations:

- 21 CFR 175.105 Adhesives
- 21 CFR 177.1590 Polyester elastomers
- 21 CFR 177.1630 Polyethylene phthalate polymers)
- 21 CFR 177.1680 Polyurethane resins
- 21 CFR 177.2600 Rubber articles intended for repeated use

Please note that INVISTA makes no representations regarding the FDA regulatory status of polymers produced from Terathane® PTMEG; it is the customer's responsibility to ensure that the Terathane® PTMEG based polymer is FDA compliant. The regulatory listings included above are merely intended to illustrate the ways in which Terathane® PTMEG potentially can be used to produce FDA-compliant polymers.

Uses

The main uses for TERATHANE® PTMEG involve the reaction of the hydroxyl groups with either isocyanates or organic acids. The glycols become segments or building blocks in a variety of elastomers, such as polyurethanes, co-polyesters and polyamides.

TERATHANE® PTMEG

Reaction with diisocyanates permits the use of TERATHANE® PTMEG as soft segments in polyurethanes[2]. If the diisocyanate is toluene diisocyanate (TDI), amines such as 4,4'-methylene-bis(2-chloroaniline) are favored as chain extenders or curatives. If diphenylmethane-4,4'-diisocyanate (MDI) is used, then 1,4 BDO is the favored chain extender[3,4].

TERATHANE® PTMEG and low molecular weight polyester glycols such as poly(butylene adipate) glycol both can yield very good polyurethanes and in most uses either can be used as the soft segment. However, a requirement for a particular property will often dictate the use of one or the other[5]. TERATHANE® PTMEG gives urethanes more resistance to low temperatures, to hydrolysis and resistance to degradation by microogranisms[4,6]. It also has excellent dynamic properties. For example, PTMEG 2900 may give a higher resilience than many other commercially available soft segments in many polyurethane formulations. TERATHANE® PTMEG imparts a low specific gravity and both the polyether glycol itself and its prepolymers have low viscosities leading to easier handling.

Polyurethane Starting Formulations

Details are available in the INVISTA technical bulletin "TERATHANE® PTMEG and 1,4 Butanediol Uses in Polyurethanes".

Storage and Handling

Precautions in Use

TERATHANE® PTMEG is a polymeric ether that is susceptible to both thermal and oxidative degradation. It contains an antioxidant to prevent formation of peroxides under normal handling and storage conditions. Peroxide formation can result in chain cleavage and therefore must be avoided.

Thermal decomposition occurs at 210–220°C (410–430°F) with extremely flammable tetrahydrofuran (THF) as one of the products[7]. Temperatures as low as 100°C (212°F) can cause dangerous pressure buildup in stored drums if the drums are unvented. To store drums containing TERATHANE® PTMEG, vent off pressure by loosening bungs before heating and store at 70°C (160°F) or less.

Oxidative degradation occurs when TERATHANE® PTMEG contact air. It is usually encountered when high surface area material, eg. pipe insulation, is impregnated with TERATHANE® PTMEG. Decomposition under these conditions can occur at temperatures as low as 100°C (212°F) with evolution of THF, aldehydes and ketones, which have a characteristic pungent odor and lachrymatory properties. The heat of the oxidative degradation is sufficient to sustain the decomposition reaction and cooling the mass is the only satisfactory way of terminating the reaction.

Water spray, alcohol-resistant foam, dry chemical or CO_2 extinguishers may be used to fight TERATHANE® PTMEG fires. When water or foam is used, frothing may occur[7].

Spills

For spill handling and cleanup information, please refer to the Safety Data Sheet.

Transportation Emergencies

If a transportation emergency arises in the continental United States, call (800) 424-9300 toll free. You will be connected with the Chemical Manufacturers Association's Chemical Transportation Emergency Center (Chemtrec) in Washington, DC. The Chemtrec telephone is attended around the clock to provide expert help. Chemtrec specialists relay handling and hazard information and report the accident to the shipper.

Unloading and Transfer

Drums should be stored in a warm room to prevent freezing. TERATHANE® PTMEG is hygroscopic. INVISTA recommends that nitrogen be used to prevent moisture contamination during thawing. As a polymer, TERATHANE® PTMEG has a certain molecular weight distribution and a separation takes place in the drum over the storing time and upon freezing. Frozen drums can be thawed by loosening the bung caps and storing for at least one day in a warming oven or thaw box at 60-70°C in order to liquefy the contents. The material in the drum should be homogenized before use. Prior to opening a drum, any water in the depression in the bung should be removed. To prevent moisture and oxygen contamination, drums should be opened under a nitrogen blanket.

Bulk truck shipping temperatures are normally 80–100°C (175–210°F). At the receiving site, the polyether glycols are often still hot enough to cause thermal burns on skin contact.

If shipments of TERATHANE® PTMEG has been subjected to low temperature in transit, careful attention will be required to avoid plugging of vent, product and gas supply lines. Cargo tanks are typically insulated and provided with heating coils to reheat the contents if required.

A typical tank truck unloading and storage system is shown in **Figure 3**.

Figure 3. Typical Tank Truck Unloading and Outdoor Storage System Glycols

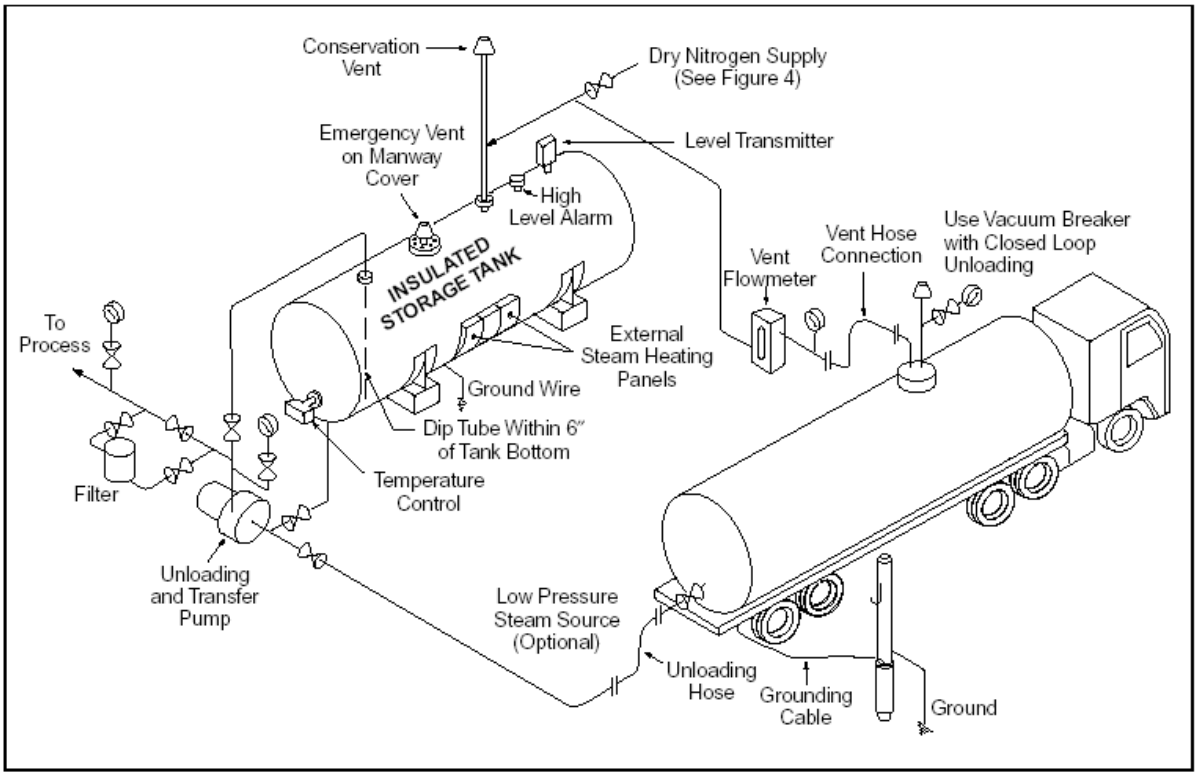
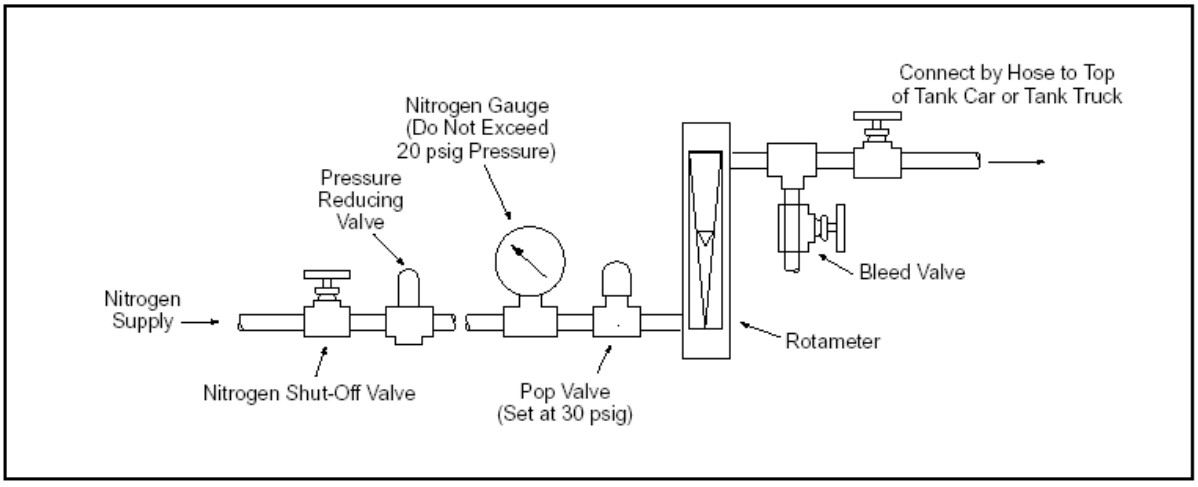


Figure 4. Typical Piping Arrangement for Nitrogen Blanketing



Notes:

- *Use a 0–15 cfm (0–7 L/sec) nitrogen rotameter to balance nitrogen flow with liquid pumping rate. This maintains positive pressure on cargo tank. Flow rate of 13.3 cfm is equivalent to a glycol flow rate of 100 gpm (both 6.3 L/sec).*
- *Caution—The cover over the nitrogen valves on the dome of a tank car is hinged and a potential pinch point.*

Storage

TERATHANE® PTMEG is hygroscopic and can oxidize. They should be stored in completely enclosed tanks under a dry nitrogen blanket. Do not store in containers with a low barrier to oxygen, such as polyethylene.

The storage tank should be provided with external or internal heating to maintain a temperature of about 50°C (120°F). Tanks should be designed and built in accordance with good industrial practice and appropriate federal, state and local codes.

References and Notes

1. Due to changing government regulations, such as those of the U.S. Department of Transportation, Department of Labor, Environmental Protection Agency and the Food and Drug Administration, and corresponding agencies in other countries, references herein to government requirements may be superseded. Each user should consult and follow the current government regulations, such as Hazard Classification, Labeling, Food Use Clearances, Worker Exposure Limitations and Waste Disposal for the up-to-date requirements for the products described in this bulletin.
2. M. E. Kimball and G. S. Fielding-Russell, *Effect of Cure Temperature on Urethane Networks;* Polymer, 18, 777 (Aug. 1977).
3. E. L. Hagen, *Solve MDI Prepolymer Processing Problems;* Plas. Tech., 95, Sept. 1978. 4. C. S. Schollenberger and F. D. Stewart, *Thermoplastic Polyurethane, Hydrolysis Stability;* Adv. in Urethane Sci. and Technol., 1, 65–93, Technomic Publishing Co. (1971).
4. C. S. Schollenberger and F. D. Stewart, *Thermoplastic Polyurethane, Hydrolysis Stability*; Adv. In Urethane Sci. and Technol., 1, 65-93, Technomic Publishing Co. (1971).
5. R. J. Ferrari, *Urethane Elastomers— A Comparison;* Rubber Age, 54, Feb. 1967.
6. H. G. Reinhardt, *Verarbeitung und Anwendung von Polyaetherurethan Elastomeren;* Kunststoffe, 67, 11 (1977).
7. "Fire Hazard Properties of Flammable Liquids, Gases, Volatile Solids"; National Fire Protection Association, No. 325M, 1977.

For high-performance polyurethane ingredients, TERATHANE® PTMEG delivers hydrolysis resistance, low temperature flexibility and excellent dynamic properties. High-quality polyols for demanding applications!

TERATHANE® PTMEG 250 • **TERATHANE®** PTMEG 1400
TERATHANE® PTMEG 650 • **TERATHANE®** PTMEG 1800
TERATHANE® PTMEG 1000 • **TERATHANE®** PTMEG 2000
TERATHANE® PTMEG 2900

We invite you to contact us.

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