



Polyethylene Glycols (PEGs)

Overview

Polyethylene glycols are polymers of ethylene oxide. PEGs are commonly used as versatile functional fluids and chemical intermediates primarily through reacting with fatty acids to make esters. As PEG molecular weight increases, viscosity and freezing point increases, and solubility in water decreases. Even at the highest molecular weights, PEGs are highly water-soluble. Low molecular weight PEGs (<600) are clear liquids above 24°C. Waldis PEG products can be blended to produce materials with a specific viscosity, texture, or melting point.

Properties ¹							
Polyethylene Glycols	CTFA Nomenclature	Molecular Weight	Specific Gravity ² @ 25/25°C	Average Viscosity ³ , cSt @ 40°C	Flash Point ⁴ , °C	Average Freezing Point ⁵ , °C	Refractive Index ⁶ @ 25°C
PEG200	PEG200	200	1.124	22	171	super cools	1.459
PEG400	PEG400	400	1.125	41	202	6	1.465
PEG600	PEG600	600	1.126	59	210	21	1.466

¹ Typical properties, not to be construed as specifications.
² ASTM D 892
³ ASTM D 445/446
⁴ ASTM D 92
⁵ ASTM D 1177-94
⁶ ASTM D 1218

Shared Properties of Waldis Polyglycols

Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties.

Property	Overview
Excellent solvency	Polyglycols dissolve or are compatible with many performance additives and are miscible in various organic liquids.
Lubricity	Waldis polyglycols exhibit excellent film forming properties and low coefficient of friction.
High viscosity indices	Waldis polyglycols have great viscosity versus temperature profiles making them an excellent choice as base stocks for synthetic lubricants.
Range of viscosity	Waldis polyglycols cover a broad range of viscosity from very low to very high viscosity. PEGs and MPEGs range from low viscosity liquids to waxy solids.
Low color and odor	Waldis polyglycols are typically water white, with little or no odor.
Low ash, non-varnishing	In high temperature applications and when burned, polyglycols typically do not leave black carbon or sticky residues.
Chemical stability	Waldis polyglycols do not hydrolyze or become rancid in storage. Recommended shelf life is two years.
Low flammability	Flash points for Waldis polyglycol products are greater than 150°C, making them safe to handle and store.
Toxicological and ecotoxicological profile	Polyglycols exhibit a low order of acute toxicity by ingestion or skin exposure. Aquatic toxicity is typically low and many of the products are biodegradable. Consult individual safety data sheets for more specific information.

Ceramics

Overview

Polyethylene glycols (PEGs) contribute green strength and good formability to ceramic mixes, and serve as binders in ceramic glazes. Because they provide a clean burnout during subsequent firing operations, they are ideal for a wide range of ceramics applications.

When used alone or in combination with other additives, PEGs provide uniform lubrication and good binding properties in the extrusion of ceramic tile and pipe.

Products

The following products can be used in ceramics applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

Chemical Intermediates

Overview

Polyglycols are used as chemical intermediates in a wide range of industries. All Waldis polyglycols have one or more terminal hydroxy groups which can be further reacted to modify the properties of a final product. Polyethylene glycols (PEGs) have two primary hydroxy groups and polypropylene glycols (PPGs) have two secondary hydroxy groups.

Polyethylene glycols are the most widely used polyglycol for chemical intermediates. PEGs increase the water solubility of a final product. Higher molecular PEGs will impart a greater degree of water solubility than lower molecular weight PEGs. Higher molecular weight PEGs are solids and their use as a chemical intermediate may result in a product that is solid at room temperature. The choice of which PEG to use is frequently based on the desired degree of water solubility and melting point of the final product.

Polypropylene glycols are water soluble at low molecular weights (P425), but most of the product line is considered sparingly soluble in water. They are liquids down to very low temperatures, such as 35°C. The secondary hydroxy group of polypropylene glycols is not as reactive as the primary hydroxy group on polyethylene glycols. PT-series products have three terminal secondary hydroxy groups, which provide more crosslinking sites.

Products

Any polyglycol can be used as a chemical intermediate. The following products are the most commonly used. Although each polyglycol has unique properties based on molecular weight and the monomer(s) used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Specific Applications

Nonionic Surfactants

Polyethylene glycols are esterified with fatty acids to produce nonionic surfactants. The polyethylene glycol (PEG) functions as the hydrophile, or water soluble portion, of the final product. Choice of PEG and fatty acid depends on the desired properties of the surfactant. All Waldis polyethylene glycols, from PEG200 to PEG6000, can be used as intermediates to produce these surfactants. Typical applications include cosmetic and personal care products, fermentation processes, food processing, paper processing, chemical processing, acid gas treatment, mining, oil drilling and textile processing.

UV Radiation Curable Coatings

Polyglycols are reacted with either acrylic acid or methacrylic acid to produce reactive monomers for radiation curable coatings. Lower molecular products are typically used - PEG200, PEG400 and PEG600

Epoxy Resins

The terminal hydroxy groups of polypropylene glycols are epoxidized to produce resins used in coating applications where flexibility is a requirement.

Polyurethanes

Polyethylene glycols are used in hydrophilic foams, coatings, and hydrogels.

Cleaners and Detergents

Overview

Waldis polyglycols are ideal candidates for many household and institutional cleaning formulations. They offer low foaming characteristics, excellent surfactancy, chemical stability, and excellent solvency.

Products

The following products can be used in cleaners and detergents. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Specific Applications

Household Applications

FAX nonionic surfactants reduce excessive foaming and minimize glassware spotting when used in household automatic dishwashing detergents and rinse aids. They are also used in hard surface cleaners, laundry detergents, and rinse aids.

Institutional Applications

FAX nonionic surfactants are ideal in high-temperature, machine-ware dishwashing formulations. They are also used in cleaning products used in restaurants, hospitals, schools, hotels, and other hospitality establishments.

Electronics

Overview

Water soluble polyglycols are used as base fluids for applications in the electronic industry. Water soluble polyglycols fluids are used in various aspects of the printed circuit board fabrication process. Uninhibited and inhibited EPB-Series fluids are used as solder assist fluids, and in flux formulations. Liquid polyethylene glycols (PEGs) have found use in flux formulations for cleaning printed circuit boards. They have also been added to the electroplating process to enhance performance.

Products

The following products can be used in electronics applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

Fiber and Textile Processing

Overview

Polyglycols and PEG-esters are key raw materials for the production of melt spin finish lubricants for the production of synthetic fibers. PEGs, PEG-esters, and a variety of nonionic surfactants based on PAGs are used in the various stages of textile processing as additives.

Products

The following products can be used in fiber and textile processing applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols \(PEGs\)](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Specific Applications

Spin Finish Lubricants

Polyglycols are preferred base stocks for spin finish lubricants, due to their excellent lubrication properties and non-varnish formation at high temperatures. Water-soluble PAGs are used primarily as base lubricants for spin finishing of textured fibers. PEG-esters are used as lubricant components and emulsifiers in spin finishes for various spin finish formulations.

Sizing

High molecular weight PEGs are used as sizing additives to improve the flexibility of the sizing agent film, facilitate the dry splitting process, and reduce dust formation during the weaving process.

Surfactants, Wetting, and Emulsifying Agents

PEG-esters, EO/PO block copolymers, and fattyalcohol alkoxyates are used as surfactants, wetting, and emulsifying agents in various processing steps within textile processing, such as scouring, pretreatment and dyeing. Low-foaming surfactants are preferable, to avoid excessive foaming.

Defoaming

Polypropylene glycols and EO/PO block copolymers are very effective defoamers in textile processing applications, where elimination of excessive foam is critical.

Filament Reorientation Inhibitor

In the production of viscose rayon, PEGs and their derivatives are widely used as additives in the spin bath to slow the reorientation of the filaments. This allows more stretch and produces higher tenacity yarns.

Metalworking

Overview

Polyalkylene glycols (PAGs) are used as lubricity ingredients in cutting, grinding, drawing, stamping and rolling lubricants. Benefits provided by PAGs are low volatility, natural lubricity, resistancy to residue formation, heat transfer characteristics and inverse water solubility (cloud points). The cloud point is particularly advantageous in aqueous metalworking fluids when the fluid is heated above its cloud point by the hot tool or workpiece. At this temperature, the PAG will come out he will deposit on a hot metal surface to form an excellent thin lubricant film. The PAG provides good lubricity at the point of cut or deformation.

Products

The following products can be used in metalworking applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols \(PEGs\)](#)

[PEG200](#)

[PEG400](#)

Specific Applications

Specific uses of polyglycols in metalworking applications include:

buffing and polishing compounds

cutting and grinding fluids

lubricants for metal stamping, rolling and forming

aluminum rolling

Oil and Gas

Overview

Polyethylene glycols (PEGs) and their esters are useful in a wide range of oil and gas industry applications.

Products

The following products can be used in oil and gas applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Specific Applications

Uses of polyglycols in oil and gas industry applications include:

acid gas treatment

crude oil demulsifiers

decolorizers for distillate-type fuel oils

drilling fluid additives

fire-resistant hydraulic fluids

fuel additives

metal corrosion inhibitors in oil wells producing brine that contains hydrogen sulfide or carbon dioxide

modifiers for silica-filled petroleum asphalt to improve softening points, temperature susceptibility, and high resistance to flow

selective solvents for removing halogens from hydrocarbons

Paint and Coatings

Overview

Polyethylene glycols (PEGs) are used as modifiers for alkyd resins to obtain water dispersibility. The addition of 15 to 25 percent PEG to the resin base produces a water dispersible resin which can be thinned to any desired degree, allowing resins to dry quickly and withstand repeated washing. PEG1500 is recommended for this application.

PEGs are also used:

as elastomers, to improve flexibility

in adhesives and sealants

as plasticizers for latex paints

as water-soluble vehicles for artists' watercolor paints

Products

The following products can be used in paint and coatings applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below. [Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Paper Processing

Overview

In paper processing applications, polyglycols are typically used as processing aids (defoaming and deinking agents). They are also used as additives, to achieve specific properties within the final paper product.

Products

The following products can be used in paper processing applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG200](#)

[PEG400](#)

[PEG600](#)

[PEG800](#)

[PEG1500](#)

[PEG4000](#)

[PEG6000](#)

Specific Applications

Defoaming

Polypropylene glycols and EO/PO block copolymers are very effective foam control agents in the paper making process. PAGs may also be used as defoamers in paper coating, size press applications, and wastewater treatment.

Deinking Surfactants

Fattyalkohol and other hydrophobic initiated alkoxyates are very effective surfactants for the removal of ink from waste paper in the flotation process.

Coatings and Sizing

As a lubricant in starch or protein surface sizing, Polyglycol PEG4000 can be used alone or in combination with calcium stearate emulsions. In paper coatings, PEGs disperse pigments and act as a plasticizer.

Photos, Maps and Gift Wrap

Liquid PEGs are used in photographs, maps, and gift wrap. These polyglycols soften and add flexibility, add desirable slip characteristics, and prevent swelling or curling of the paper caused by humidity.

Toweling

PEGs are used as re-wetting agents for wet-strength toweling.

Personal Care

Overview

Polyglycols are widely used in personal care products, especially polyethylene glycols (PEGs). There are many typical properties of polyglycols beneficial to personal care formulations:

neutral and low in odor

relatively low toxicity and low skin irritation potential

do not become rancid and seldom react with other ingredients

dissolve many cosmetic ingredients

The extensive range of Waldis polyglycols includes products from fully water soluble to vegetable oil soluble. The polyethylene glycols range from liquids to prilled solid grades. PEGs can be blended together to vary the final product form and melt point.

Products

The following products can be used in personal care products. Although each polyglycol has unique properties based on molecular weight and the monomer(s) used, they all share some common properties. To learn more about a product family, choose from the table below.

Polyethylene Glycols

PEG200

PEG400

PEG600

PEG800

PEG1500

PEG4000

PEG6000

Functionality

The choice of polyglycol brings different benefits to personal care formulations. Listed below are the functionalities of different product families.

Functionality	Polyglycols
Binders	PEG1500, PEG4000, PEG6000
Hair Conditioning Agents	
Humectants	Polyethylene glycols
Skin Conditioning Agents	
Solvents	Polyethylene glycols, Polyglycol 15-200
Surfactants – Emulsifying Agents	

Specific Applications

Polyethylene glycols are used in aftershave lotions, bath soaps, cold creams and cleansing lotions, dentifrices, deodorants, makeup bases and removers, foundations, hair conditioners and straighteners, lipsticks, mascara, moisturizing preparations, mud packs, permanent waves, sachets, shaving cream, skin fresheners, suntan products, hair grooming aids, and toothpastes.

Polyethylene glycols fluids are used in antiperspirants, bubble baths, cold creams and lotions, eyeliners, hair conditioners and grooming aids, and shampoos.

The table below lists specific polyglycol product uses taken from the U.S. Food and Drug Administration's Voluntary Reporting Program².

Product Category	Polyglycols
Aftershave Lotions	PEG400
Bath Soaps	PEG400
Body and Hand Preparations	PEG400
Bubble Baths	
Cleansing Products (cold creams; cleansing lotions, liquids and pads)	PEG400, PEG1500, PEG4000 Polyglycol 15-200
Dentifrices (aerosol, liquid, pastes, and powders)	PEG1500
Deodorants (underarm)	PEG200, PEG400, P425
Eyeliners	
Eye Makeup Removers	PEG600
Face and Neck Preparations (excluding Shaving Preparations)	PEG600

Foundations	PEG400
Hair Conditioners	PEG200, PEG4000
Hair Straighteners	PEG400
Lipsticks	PEG400
Makeup Bases	PEG400
Mascara	PEG1500
Moisturizing Preparations	PEG200, PEG400, PEG1500, PEG4000
Night Skin Care Preparations	PEG400, PEG4000
Paste Masks (mud packs)	PEG400
Permanent Waves	PEG4000
Personal Cleanliness Products	PEG400
Sachets	PEG1500
Shampoos (non-coloring)	
Shaving Cream (aerosol, brushless, and lather)	PEG400
Skin Care Preparations, Misc.	PEG400, PEG4000
Skin Fresheners	PEG400
Suntan Gels, Creams, and Liquids	PEG400
Suntan Preparations, Misc.	PEG1500
Tonics, Dressings, and Hair Grooming Aids	PEG400

¹ These PEGs are available in Industrial and National Formulary (NF) grades.

² CTFA Cosmetic Ingredient Handbook, 2nd ed., 1992

Note: The inclusion of products on the lists and tables above does not indicate that use of that product as a cosmetic ingredient complies with the laws and regulations governing such use in the United States or any other country.

Rubber and Plastics

Overview

In rubber applications, polyethylene glycols (PEGs) and random copolymers (PAGs) are primarily used as mold release agents for rubber articles and formed rubber hoses. In plastic applications, polypropylene glycols (PPGs) and polyethylene glycols (PEGs) are used as radiation stabilizers, and as additives to impart anti-static and scratch resistance properties.

Products

The following products can be used in rubber and plastics applications. Although each polyglycol has unique properties based on the molecular weights and the oxides used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG400](#)

[PEG600](#)

[PEG4000](#)

Synthetic Lubricants

Overview

Polyalkylene glycols (PAG) are used as synthetic lubricants in many diverse applications where petroleum oil based products do not provide the desired performance. PAG characteristics that lead to their improved performance over petroleum based products are:

lower pour point

higher viscosity index

lower tendency of varnish or coke formation

increased solvency

wider range of solubilities, including water solubility

lower vapor pressure and ash content

PAGs are often formulated with additives to improve oxidation stability, extreme pressure loading, and corrosion inhibition

Products

The following products can be used as synthetic lubricants. Although each polyglycol has unique properties

based on molecular weight and the monomer used, they all share some common properties. To learn more about a product family, choose from the table below.

[Polyethylene Glycols](#)

[PEG400](#)

[PEG800](#)

[PEG4000](#)

Specific Applications

PPGs display minimal tendency toward the formation of varnish and coke deposits at high temperatures and are used as carriers for solid lubricants, such as graphite and molybdenum disulfide. Formulated with thickeners, PPGs are used as greases in high temperature applications where mineral oil formulations would result in coke-type deposits.

PPGs are used in synthetic lubricants including:

hydraulic fluid lubricant

gear lubricant

calender lubricant

textile processing

LDPE hyper-compressor

two-stroke engine

Water and Wastewater Treatment

Overview

Polyglycols are commonly used for foam control in water and wastewater treatment applications. They can be used either as neat products or as components of foam-control formulations.

Products

The following products can be used in water and wastewater treatment applications. Although each polyglycol has unique properties based on molecular weight and the monomer used, they all share some common properties.

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Polyethylene Glycols (PEGs)

WALDIS CHEMICALS