

Choosing the best glycol ether for your industrial and institutional cleaning formulations

Dow Glycol Ethers improve the cleaning performance of your formulation, while meeting all your formulation needs. Both oil and water soluble glycol ethers increase soil penetration and lifting, surface wetting, and coupling. All these properties work together to maximize formulation performance.

Physical properties

Product name	Chemical name	Boiling point (°C)	Flash point (°C)	Solubility @ 25°C (g in 100g water)	Consumer products US EPA LVP Exemption ¹
DOWANOL™ PM	Propylene Glycol Methyl Ether	120	31	∞	VOC
DOWANOL™ DPM	Dipropylene Glycol Methyl Ether	190	75	∞	VOC
DOWANOL™ TPM	Tripropylene Glycol Methyl Ether	243	121	∞	Not VOC
Butyl CELLOSOLVE™ (BuCs)	Ethylene Glycol n-Butyl Ether	171	65	∞	VOC
Butyl CARBITOL™ (BuCb)	Diethylene Glycol n-Butyl Ether	230	99	∞	Not VOC
DOWANOL™ PnP	Propylene Glycol n-Propyl Ether	149	48	∞	VOC
DOWANOL™ DPnP	Dipropylene Glycol n-Propyl Ether	213	88	17.2	Not VOC
DOWANOL™ PnB	Propylene Glycol n-Butyl Ether	171	63	5.5	VOC
DOWANOL™ DPnB	Dipropylene Glycol n-Butyl Ether	230	100	4.5	Not VOC
DOWANOL™ TPnB	Tripropylene Glycol n-Butyl Ether	274	126	3	Not VOC
DOWANOL™ EPH	Ethylene Glycol Phenyl Ether	244	121	2.5	Not VOC
Hexyl CARBITOL™ (HeCb)	Diethylene Glycol Hexyl Ether	259	135	1.4	Not VOC
Hexyl CELLOSOLVE™ (HeCs)	Ethylene Glycol Hexyl Ether	208	91	0.9	Not VOC
DOWANOL™ PPh	Propylene Glycol Phenyl Ether	243	119	1	Not VOC
DOWANOL™ DiPPh	Dipropylene Glycol Phenyl Ether	280	138	<1	Not VOC

¹40 CFR Chapter 1 Subpart C. National Volatile Organic Compound Emission Standards for Consumer Products, 59.203 From 63 FR 48831 Sept 11, 1998

Performance comparison for hard surface cleaning

When choosing a Dow Glycol Ether for your formulation, it's important to keep in mind the soil and substrate you are trying to clean.

Key property item	Solubility for limescale (see Figure 2)	Solubility for soap scum (ex. bathroom cleaner)	Miscibility improvement for soybean oil	Miscibility improvement for vegetable oil and water	Surface wetting
Hexyl CELLOSOLVE™ & Hexyl CARBITOL™	+++	+++	+++	+	+++
DOWANOL™ PPh, DiPPh & EPh	++	+++	+++	+	+
DOWANOL™ PnB, DPnB & TPnB	+	++	++	+++	+++
DOWANOL™ DPnP	+	++	++	+++	++
Butyl CELLOSOLVE™ & Butyl CARBITOL™	+	++	+	++	++
DOWANOL™ PM, DPM & TPM	+	++	+	+	+

+++ Excellent ++ Good + Moderate

Excellent cleaning efficacy for multiple soils

Hydrophobic solvent in the cleaner partitions out of the water and into the soil (see Figure 1). This reduces the soil viscosity and surface tension with water. This softening of the soil, which is a typical characteristic of glycol ethers in aqueous cleaners, allows for mechanical breakup. Without this softening, removal would be impossible or very difficult.

In this soil solubility study, low HLB (Hydrophilic-Lipophilic Balance) glycol ethers worked as the most effective cleaner, typically Hexyl CELLOSOLVE™, Hexyl CARBITOL™, DOWANOL™ PPh, DiPPh, and EPh, while high HLB glycol ethers worked as the least effective for heavy soils (see Figures 2, 3 and 4).

Figure 1: Entropic swelling mechanism

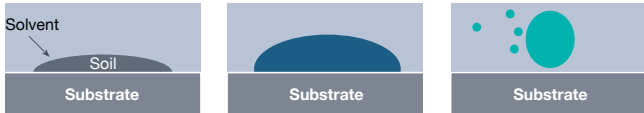


Figure 2: % Cleaned – Limescale with 1.5 wt% glycol ethers

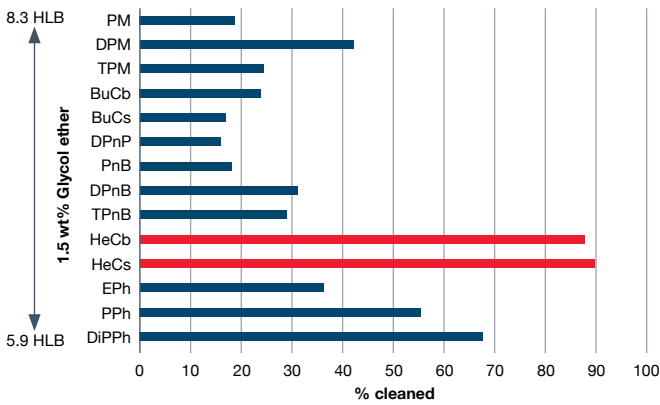


Figure 3: % Cleaned – Soap scum with 1.5 wt% glycol ethers

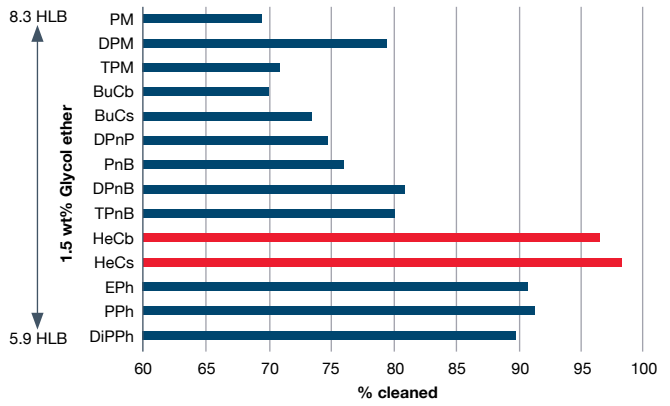
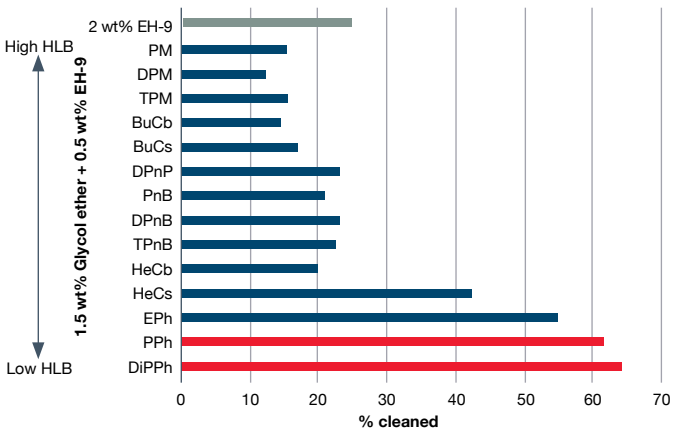


Figure 4: % Cleaned – Soybean oil with 1.5 wt% glycol ethers + 0.5 wt% ECOSURF™ EH-9 Surfactant



Test conditions:

- Prepare the test formulation (carbon black + triglyceride + naphtha + soil) on white composite tile after air dry.
- Samples were cleaned with 0.4 mL of glycol ether solution in a custom high throughput apparatus.
- Measure the gray scale by colorimetry.

ECOSURF™ Surfactants are sold under the TERGITOL™ tradename in Canada and Japan



Dynamic surface tension reduction/ high wetting property

Cleaning by soil roll-up can be accomplished by glycol ethers (see Figure 5). The solvent must have a lower surface tension than the soil, and must be partially (not fully) soluble in the soil it is displacing.

Water-based cleaner formulations containing DOWANOL™ PnB series exhibit lower dynamic surface tensions than formulations containing traditional surfactants alone, because glycol ethers should have lower molecular weight than the surfactants. Compared to high HLB Glycol Ethers like DOWANOL™ PM series and Butyl CARBITOL™ Solvent, DOWANOL™ PnB series is highly effective in lowering dynamic surface tension (see Figure 6). In addition, Hexyl CELLOSOLVE™ and Hexyl CARBITOL™ Solvents reduce the surface tension of water efficiently even when considering their lower solubility limits.

Figure 5: Soil roll-up mechanism

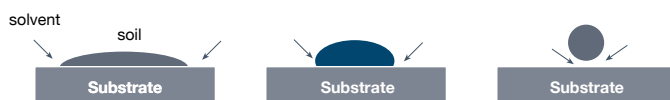
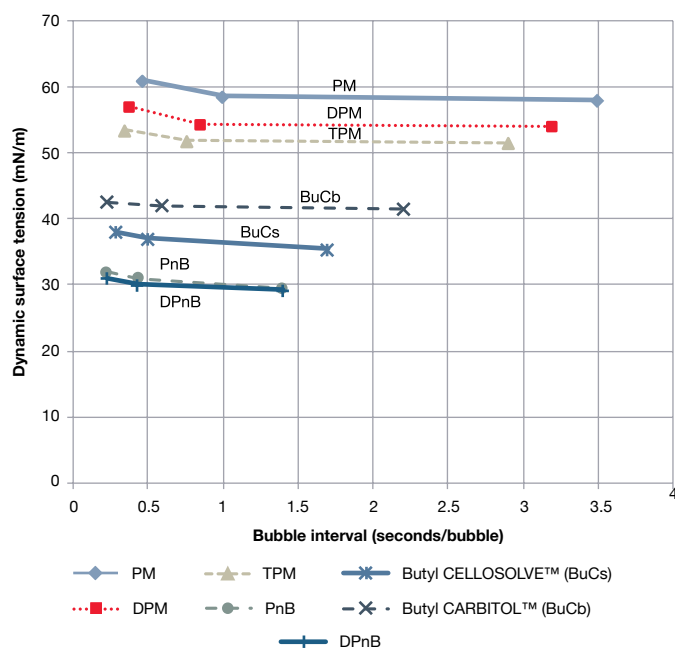


Figure 6: Dynamic surface tension reduction capability of dow glycol ethers at 5 wt%



Excellent coupling ability

Coupling is a method of compatibilizing a multiphase system that results in an increase in the degree of homogeneity of the system. Dow Glycol Ethers couple oil-soluble soil with water and, together with the surfactant, keep the soil suspended in the cleaning solution to prevent it from being re-deposited on the cleaned surface.

Evaporation rate flexibility

Dow Glycol Ethers offer a wide range of evaporation rates for formulation requirements. For example, DOWANOL™ PnP, DOWANOL™ PnB and Hexyl CELLOSOLVE™ Solvent are excellent choices for a window cleaner that evaporates fast enough to prevent streaking. On the other hand, slower evaporating products such as DOWANOL™ DPnB, DOWANOL™ TPnB, DOWANOL™ PPh, DOWANOL™ DiPPh, DOWANOL™ EPh or Hexyl CARBITOL™ Solvent do well in formulations such as grill and oven cleaners, where they provide the longer contact time necessary to thoroughly penetrate the heavy greasy oil and baked-on material.

Starting formulations

All Purpose hard surface cleaner #1 (VOC exempt) ¹	
ECOSURF™ EH-9	2.0 wt%
TRITON™ CG-650	1.0 wt%
DOWANOL™ DiPPh ²	1.0 wt%
DOWANOL™ TPM	1.0 wt%
Diisopropanolamine (DIPA)	0.5 wt%
Water	to 100

¹Exempt from VOC Regulations according to US EPA Low Vapor Pressure (LVP), 40 CFR Chapter 1 Subpart C. National Volatile Organic Compound Emission Standards for Consumer Products, 59.203 from 63 FR 48831 Sept 11, 1998

²DOWANOL™ DPnB, TPnB, PPh, EPh, or Hexyl CARBITOL™ may be substituted for DOWANOL™ DiPPh in this formulation

All purpose hard surface cleaner #2 (Spray cleaning)	
DOWANOL™ DPM	2.5 wt%
DOWANOL™ DPnB	1.5 wt%
DOWFAX™ 3B2	1.75 wt%
ECOSURF™ EH-9	2.0 wt%
Coco fatty acid soap	0.3 wt%
Triethanolamine (TEA)	2.0 wt%
NaHCO ₃	0.5 wt%
Sodium citrate	1.5 wt%
Perfume	0.25 wt%
Water	to 100

Window cleaner	
DOWANOL™ PnB	4.0 wt%
ECOSURF™ EH-6	0.2 wt%
Monoethanolamine (MEA)	0.3 wt%
Citric acid	pH adjust (10<pH<11)
Perfume	0.1 wt%
Water	to 100

Grill & oven cleaner	
DOWANOL™ DiPPh ¹	2.0 wt%
TERGITOL™ 15-S-12	2.0 wt%
ECOSURF™ EH-9	2.0 wt%
Diisopropanolamine (DIPA)	2.0 wt%
Water	to 100

¹DOWANOL™ DPnB, TPnB, PPh, EPh, or Hexyl CARBITOL™ may be substituted for DOWANOL™ DiPPh in this formulation.

Floor cleaner	
DOWANOL™ EPh	2.0 wt%
DOWANOL™ PnB	4.0 wt%
Triethanolamine (TEA)	12.0 wt%
Oleic Acid	16.0 wt%
Water	to 100

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