



ECOSURF™ EH SPECIALTY SURFACTANTS

Fast Wetting, Low Odor, Biodegradable Surfactants

EH

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Biodegradable Surfactants that Meet U.S. EPA
Design for the Environment Surfactant Screen Criteria



ECOSURF™ EH Surfactants are a new generation of high-performance, readily biodegradable specialty surfactants that are fast wetting and have low odor. They are designed for use in hard surface cleaning, textile processing, and wetting of both hard and soft surfaces.

ECOSURF™ EH Surfactants have an excellent environmental profile: they are readily biodegradable (> 60 percent biodegradation within 28 days per OECD 301F) and have an aquatic toxicity $EC_{50} > 10$ mg/L. These surfactants meet the criteria for the U.S. Environmental Protection Agency (EPA) *Design for the Environment* Surfactant Screen.

ECOSURF™ EH Surfactants are part of the expanding range of ECOSURF™ Surfactants, a line of specialty surfactants designed to help formulators meet rising expectations for performance and convenience in the marketplace while complying with rapidly increasing, more stringent environmental and safety regulations.

ECOSURF™ EH Surfactants are non-ionic surfactants that provide performance equal to alkylphenol ethoxylate (APE) surfactants, and better than primary alcohol ethoxylate (PAE) surfactants in many applications, including hard surface cleaning, textile processing, and any application in which excellent wetting performance is required. For hard-surface cleaning of cross-linked triglycerides (kitchen soil) and mineral oil (industrial petroleum based grease), ECOSURF™ EH Surfactants clean as well as TERGITOL™ NP-9 Surfactant and exhibit exceptional performance compared to primary alcohol ethoxylates (PAEs). All grades of ECOSURF™ EH Surfactants have an excellent environmental profile: they are readily biodegradable per OECD 301 F, and have an aquatic toxicity $EC_{50} > 10$ mg/L. ECOSURF™

EH Surfactants are low odor and low foam products, and have a very narrow gel range, making them an ideal choice for use in concentrated formulations.

The line of ECOSURF™ EH Surfactants includes three products: ECOSURF™ EH-3 Surfactant, ECOSURF™ EH-6 Surfactant and ECOSURF™ EH-9 Surfactant.

ECOSURF™ EH-3 Surfactant

ECOSURF™ EH-3 Surfactant is an excellent oil-soluble emulsifier with a low HLB, ideally suited for nonaqueous hard surface cleaning applications. It can be combined with higher mole EH Surfactants to improve water solubility, and enhance oily soil removal. ECOSURF™ EH-3 Surfactant has low foam and very low odor. Its narrow gel range makes it appropriate for ultraconcentrate formulas. It exhibits fast dynamic surface tension reduction. Dow's internal tests indicate that ECOSURF™ EH-3 is the only low mole surfactant currently on the market that exhibits aquatic toxicity > 10mg/L.

ECOSURF™ EH-6 Surfactant

With exceptional wetting capabilities, ECOSURF™ EH-6 Surfactant is ideally suited for many hard surface cleaning applications, including metal cleaning. Especially effective on greasy kitchen soils, it has low foam and very low odor, and is easy to formulate. Its narrow gel range makes it appropriate for ultraconcentrate formulas. It exhibits fast dynamic surface tension reduction, and has low aquatic toxicity.

ECOSURF™ EH-9 Surfactant

With exceptional wetting capabilities, ECOSURF™ EH-9 Surfactant is ideally suited for hard surface cleaning applications. It has low foam and very low odor, and is an ideal choice for higher temperature applications. Its narrow gel range makes it appropriate for ultraconcentrate formulas. It exhibits fast dynamic surface tension reduction, and has very low aquatic toxicity.

BIODEGRADABLE



Excellent Environmental Profile

ECOSURF™ EH Surfactants have an excellent environmental profile: they are readily biodegradable per OECD 301 F, and have an aquatic toxicity $EC_{50} > 10$ mg/L. These surfactants meet the criteria for the U.S. Environmental Protection Agency (EPA) *Design for the Environment* Surfactant Screen. Compared to primary alcohol ethoxylates and nonylphenol ethoxylates (Table 2), ECOSURF™ EH Surfactants can provide greater flexibility to meet increasingly stringent environmental regulations, even at low levels of ethoxylation.

Table 1 – Typical Physical Properties¹ of ECOSURF™ EH Surfactants

	ECOSURF™ EH-3	ECOSURF™ EH-6	ECOSURF™ EH-9
Actives Content, wt %	100	100	100
Solvent	None	None	None
Appearance	Pale yellow liquid, Clear to slightly hazy	Pale yellow liquid, Clear to slightly hazy	Pale yellow liquid, hazy
Cloud Point, 10% in 25% DB/Water (°C)	52	66	74
Cloud Point, 10% in Water (°C)	dispersible	43	64
HLB	7.9	10.8	12.5
Viscosity at 40°C (104°F), cS	25	37	49
Pour Point, °C (°F)	-24 (-11)	3 (37)	12 (54)

¹Typical properties, not to be construed as specifications

Table 2 – Aquatic Toxicity

Product	Readily Biodegradable (OECD 301 F)	Aquatic Toxicity, mg/L, <i>Daphnia</i>
ECOSURF™ EH Surfactants, all grades	Yes	10-100
Primary alcohol ethoxylate* C ₁₂₋₁₆ EO ₃₋₉	Yes	0.1-100
Nonylphenol ethoxylate* EO ₉	No	1-10

* Talmage, Sylvia S. *Environmental and Human Safety of Major Surfactants*. Boca Raton, FL: Lewis, 1994.



PERFORMANCE OF ECOSURF™ EH SURFACTANTS

ECOSURF™ EH Surfactants equal or surpass the performance of other surfactants under most formulation conditions, according to Dow internal studies, as shown in Table 3.

Table 3 – Surfactant Performance Comparison

Product	Wetting @ 0.1%	Gel Formation	Pour Point	Formula Stability	Hard Surface Cleaning	Aquatic Toxicity	Biodegradation
ECOSURF™ EH Surfactants	E	E	E	E	E	E	G
Alcohol Alkoxylate	E	E	E	E	M	M	G
Nonylphenol ethoxylate	E	P	G	G	E	M	P
Primary alcohol ethoxylate (C ₁₂ -C ₁₅)	E	P	P	G	M	M	G

P = Poor, M= Marginal, G = Good, VG = Very Good, E = Excellent
Comparison based on cloud point

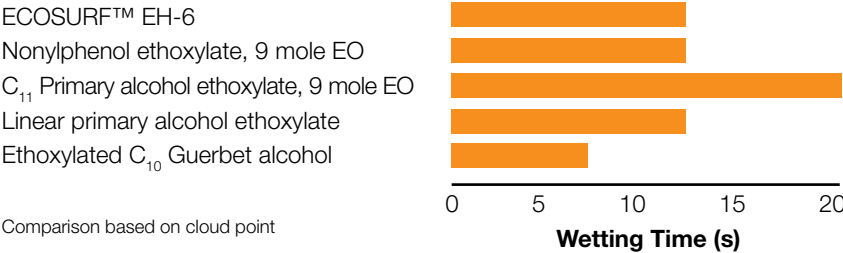
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Fast Wetting Performance

ECOSURF™ EH Surfactants provide excellent wetting. At concentrations above 0.05%, ECOSURF™ EH Surfactants provide 20 second wetting times, per the Draves Wetting test method. Their wetting performance is comparable to many other surfactant types. See Figure 1.

Figure 1 – Draves Wetting Performance, 0.1% Aqueous Surfactant at 25°C



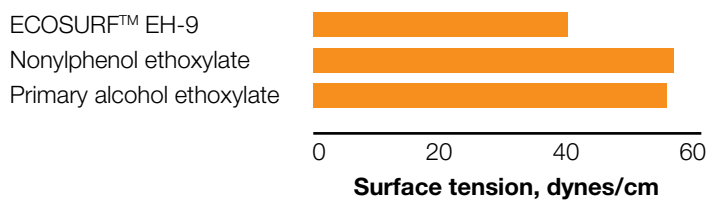
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Dynamic Surface Tension

ECOSURF™ EH Surfactants exhibit the fast dynamic surface tension characteristic of C₉₋₁₀ alcohol ethoxylates, making them an excellent choice for fast cleaning processes such as bottle washing.

Figure 2 – Dynamic Surface Tension at 10 mSec Surface Age, 1000 ppm Aqueous Surfactant at 25°C

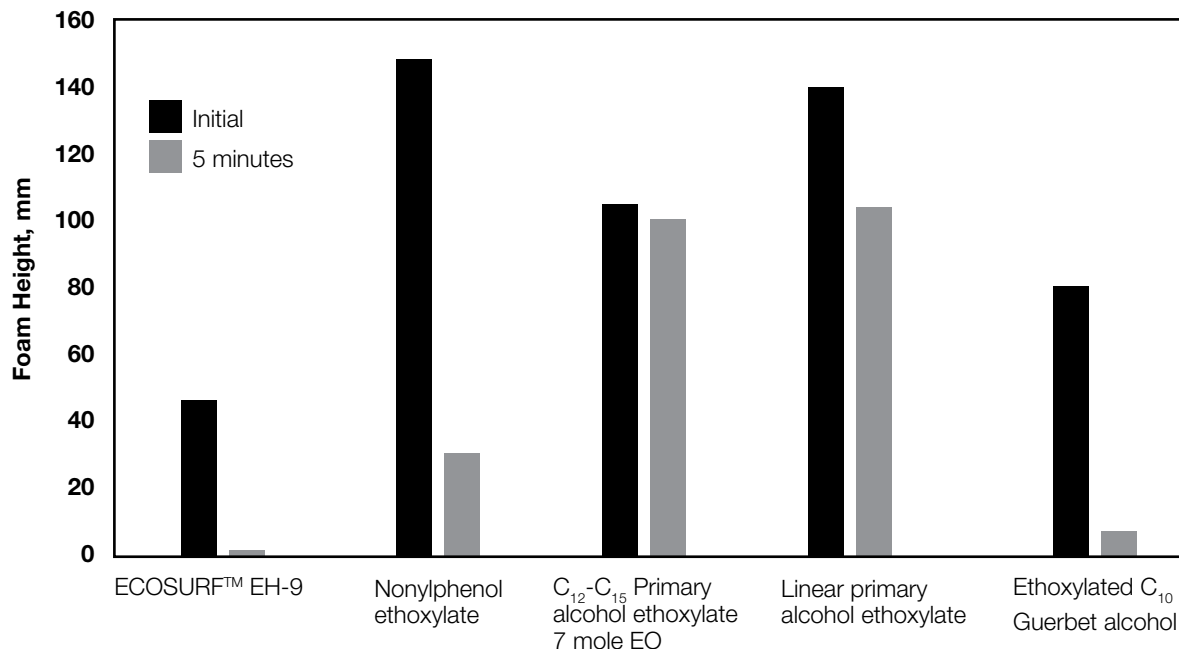




Low Foaming Profile

ECOSURF™ EH Surfactants are low foam and provide very rapid foam collapse. Dow internal studies indicate that ECOSURF™ EH Surfactants excel under this measure of performance, as seen in Figure 3. This property makes ECOSURF™ EH Surfactants excellent candidates for hard surface cleaners that must minimize both foam generation and persistence. The rapid foam collapse can also improve risibility. Overall, these low foaming properties can improve formulation efficiency and reduce or eliminate the need for foam control agents.

Figure 3 – Comparative Ross-Miles Foam Profiles, 0.1% Surfactant @ 25°C



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Formula Stability

ECOSURF™ EH Surfactants are chemically stable in the presence of dilute acids, bases and salts. They may be used in the presences of cationic antimicrobial agents. They are compatible with anionic, cationic and other nonionic surfactants, providing significant formulating flexibility. They provide better formula stability than comparable NPE and PAE surfactants. Table 4 compares the stability of ECOSURF™ EH-9 Surfactant in Dow tests with two comparable alkoxyates in three aqueous formulations.

**Table 4 – Formula Stability Comparison
5% Surfactant, aqueous formulation**

Formula Composition	ECOSURF™ EH-9 Surfactant	NPE Surfactant	PAE Surfactant
15% LAS/2% Na Cit	S	S	S
15% LAS/4% Na Cit	S	U	S
15% LAS/6% Na Cit	S	U	U

LAS = Linear Alkyl Sulfonate Na Cit = Sodium Citrate U = Unstable S = Stable

Surfactant comparison based on cloud point.



Formula Stability at 25°C



ECOSURF™ EH-9
Stable

NPE
Unstable

ETH



Hard Surface Cleaning Performance

ECOSURF™ EH Surfactants have demonstrated exceptional hard surface cleaning performance in Dow tests. Figure 4 compares the cleaning performance of mid-range alkoxyate surfactants on a hard surface coated with a standard CSPA (Consumer Specialty Products Association) non-crosslinked soil. Clearly, ECOSURF™ EH-6 Surfactant excels in cleaning relative to all other benchmark surfactants for the cleaning of triglycerides.

Figure 5 compares the performance of surfactants at various concentration levels for removal of a standard CSPA Soil (vegetable oil, vegetable shortening, lard and carbon black) from a hard surface. At levels of 0.5% and higher, the ECOSURF™ EH Surfactant shows a significant improvement in performance relative to benchmark surfactants.



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Figure 4 – Hard Surface Cleaning Comparison: Triglyceride, Vegetable Oil and Carbon Black Soil. 0.5g soil, 1% Surfactant in Water

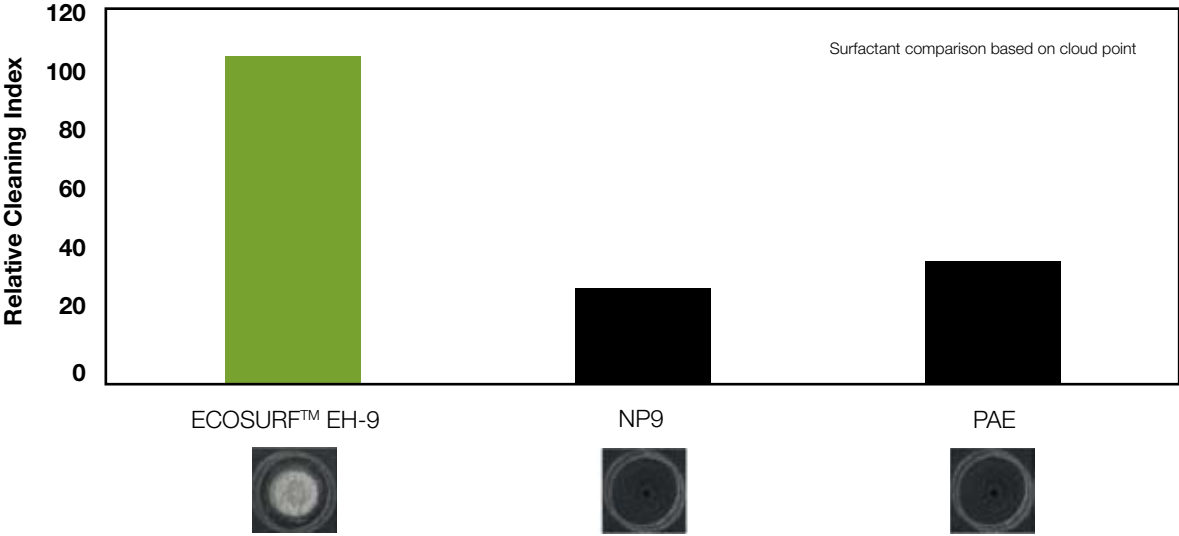
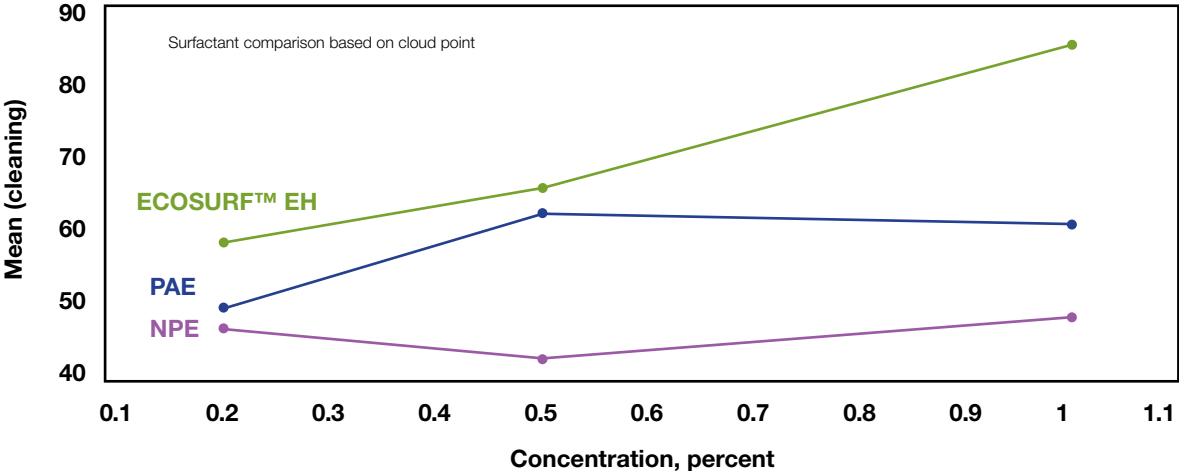


Figure 5 – Hard Surface Cleaning Comparison: Effect of Concentration



LEAN

Paints and Coatings Applications

ECOSURF™ EH Surfactants feature narrow aqueous gel ranges and favorable handling and formulating properties, making them ideally suited surfactants for many paint and coating systems. As previously seen in Figure 3, ECOSURF™ EH Surfactants are low foam and provide very rapid foam collapse compared to APE and PAE surfactants. Figure 6, below, shows 1% aqueous solutions of ECOSURF™ EH and a PAE at 20°C.

Figure 6 – 1% aqueous solution at 20°C



ECOSURF™ EH

PAE

As Figure 2 on page 8 demonstrated, ECOSURF™ EH Surfactants exhibit rapid dynamic surface tension reduction. Dow studies indicate that equilibrium surface tension is comparable to conventional pigment wetting surfactants (Table 5), but ECOSURF™ EH Surfactants offer improved handling and an improved environmental profile.

Table 5 – Equilibrium Surface Tension, 0.1% Aqueous Solution at 20°C, Dynes / cm

ECOSURF™ EH	30
Nonylphenol ethoxylate	32
Primary alcohol ethoxylate	28
Tridecyl alcohol ethoxylate	29
Branched primary alcohol ethoxylate	28

Comparison based on cloud point

Textile Applications

ECOSURF™ EH Surfactants are an ideal choice for textile applications. Dow studies have shown that fabrics finished by silicone softeners emulsified with ECOSURF™ EH Surfactants exhibited improved hand-feel. Internal studies also show excellent emulsification power toward liquid paraffin. Using real-world application testing for textile processing, the wetting times and penetration time for real-use concentrations (0.3% by weight, Figure 7) are much faster for the ECOSURF™ EH Surfactants relative to PAEs.

TEXTILES

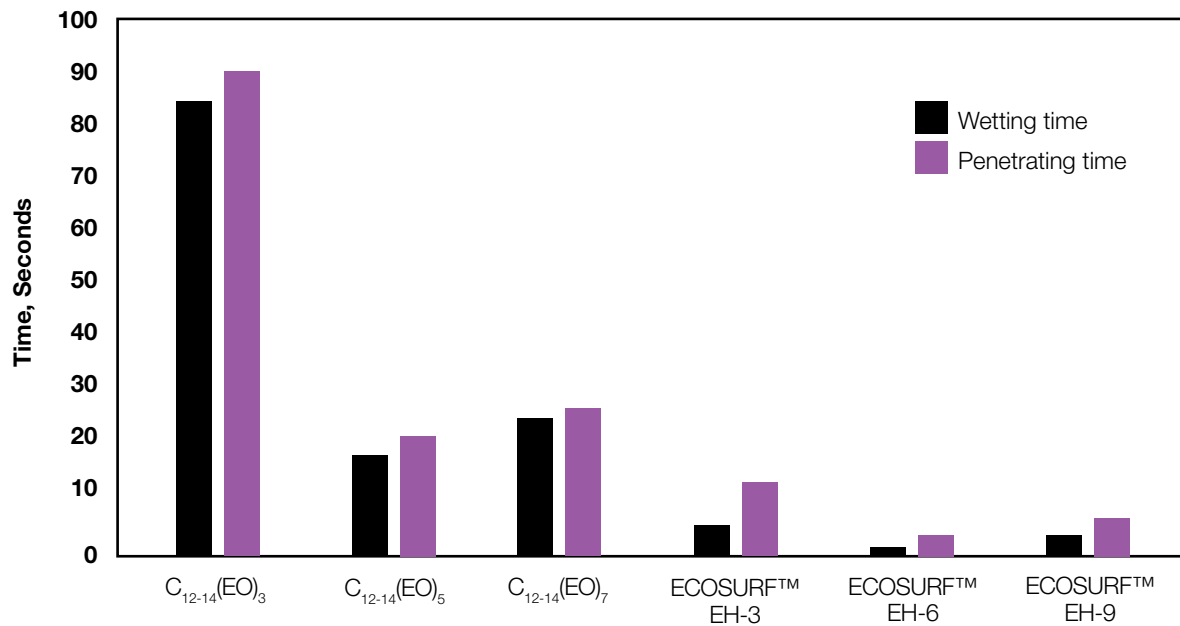


Applications

ECOSURF™ EH Surfactants are candidates for use in a variety of applications including:

- Agrochemicals
 - Emulsification and dispersion in agricultural insecticides and herbicides
- Cleaning Products
 - Hard Surface Cleaners
 - All purpose cleaners
 - Bucket dilutable cleaners
 - Concentrates
 - Disinfectants
 - Transportation Cleaners
 - Metal Cleaners
- Paints and Coatings
 - Wetting agent
 - Dispersant
- Paper Processing
- Textile Processing
 - Emulsifier for fiber lubricants
 - Wetting Agent
- Oil and Gas

Figure 7 – Wetting and Penetrating times for ECOSURF™ EH Surfactants vs. Standard C10-16 Primary Alcohol Ethoxylates (PAE)





ECOSURF™ EH SURFACTANTS

To Learn More...

To learn more about ECOSURF™ EH Surfactants, and the full line of anionic and nonionic surfactants from Dow – or to receive product samples – contact the Dow location for your region, listed below.

U.S., Canada, Mexico: call: 1-800-447-4369 fax: 1- 989-832-1465

Latin America: call: (+55) 11-5188-9222 fax: +55-11-5188-9749

Europe: call toll-free: +800-3-694-6367* call: (+32) 3-450-2240 fax: +32 3-450-2815

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*Toll free service not available in all countries

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