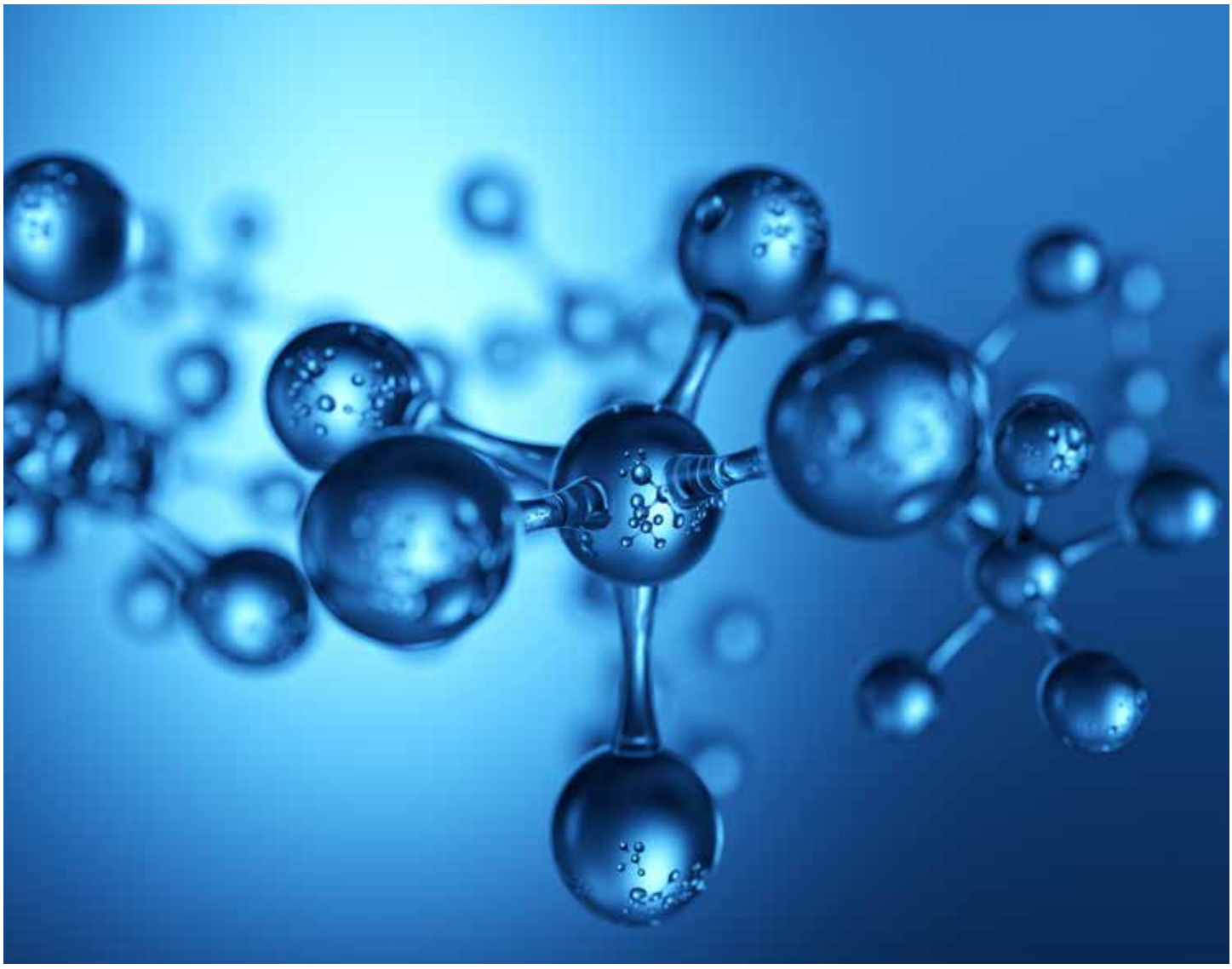
Dow Industrial Solutions

Additives and Intermediates for the synthesis of waterborne resins and hardeners



Dow combines one of the broadest technology sets in the industry with asset integration, focused innovation and global scale to achieve profitable growth and become the most innovative, customer centric, inclusive and sustainable materials science company. Dow's portfolio of performance materials, industrial intermediates and plastics businesses delivers a broad range of differentiated science-based products and solutions for our customers in high-growth segments, such as packaging, infrastructure and consumer care. Dow operates 113 manufacturing sites in 31 countries and employs approximately 37,000 people across the world. Dow delivered pro forma sales of approximately $50 billion in 2018.

Dow offers a variety of surfactants, oxygenated solvents and polyether polyols that can meet your diverse demands for resin synthesis applications.

Acrylic emulsion

Dow surfactants for acrylic emulsions

DOWFAX™ AS-321, AS-906 and AS-801 are environmentally friendly anionic emulsifiers with high performance, specially developed for emulsion polymerization. ECOSURF™ SA series, TERGITOL™ CA and 15-S series nonionic surfactants also bring significant performance improvement to customers in emulsion polymerization and downstream coating applications.

- **DOWFAX™ AS-321**, as a non-APE phosphate surfactant, provides outstanding performance for industrial coatings, especially water resistance and salt spray resistance, while enhancing emulsification.
- **DOWFAX™ AS-906**, as a sulfate surfactant with special structure, ensures emulsion stability, in parallel with low foam and wetting performance.
- **DOWFAX™ AS-801** is a sulfate surfactant with overall balanced performance. The emulsion synthesized with this surfactant has been widely recognized in the downstream applications.
- **DOWFAX™ 2A1**, as a classic disulfonate surfactant, gives the emulsion excellent acid and alkali resistance and thermal stability.
- **TERGITOL™ CA** series are environmentally friendly nonionic surfactants with low foam, fast wetting and low aquatic toxicity; **ECOSURF™ SA** series nonionic surfactants, derived from natural fatty alcohol, can meet the stringent environmental and safety requirements, while providing excellent performance in broad applications; **TERGITOL™ 15-S** series nonionic surfactant, as a secondary alcohol ethoxylate, demonstrates excellent performance when replacing primary alcohol ethoxylate (PAE) and alkylphenol ethoxylate (APE) surfactants in emulsion polymerization.

Emulsion type	Recommendation by DOW	Application characteristics
SA emulsion	DOWFAX™ AS-321, AS-906, AS-801, 2A1 ECOSURF™ SA-9 TERGITOL™ CA-90, 15-S-9 / 15-S-40	Good emulsification stability, outstanding low foam performance, excellent calcium stability, wetting performance and mechanical stability
PA emulsion	DOWFAX™ AS-321, AS-906, AS-801, 2A1 ECOSURF™ SA-9 TERGITOL™ CA-90, 15-S-9 / 15-S-40	Outstanding emulsification and low foam performance, excellent calcium stability, wetting performance and mechanical stability
VA emulsion	DOWFAX™ AS-801, AS-906 ECOSURF™ SA-9 TERGITOL™ 15-S-9 / 15-S-30 / 15-S-40, CA-90	Excellent emulsification, polymerization stability and effective particle size control
SB emulsion	DOWFAX™ 2A1 / 8390, AS-906 ECOSURF™ SA-9 TERGITOL™ CA-90, 15-S-9 / 15-S-40	Effective particle size control, excellent emulsification, good mechanical stability and storage stability
VAE emulsion	ECOSURF™ SA-9 TERGITOL™ 15-S-9 / 15-S-30 / 15-S-40, CA-90	Excellent emulsification, polymerization stability and effective particle size control

*SA=Styrene Acrylate, PA=Pure Acrylic, VA=Vinyl Acetate, SB=Styrene-Butadiene, VAE=Vinyl Acetate/Ethylene

Anionic surfactant

DOWFAX™ AS-321: Environmentally friendly phosphate emulsifier with high performance

Besides being environmentally friendly and safer product, DOWFAX™ AS-321 provides excellent emulsification as well as polymerization and formulation stability. Compared with similar products available in the market, it can effectively improve the performance and stability of industrial coatings.

Product features
Environmentally friendly
Excellent emulsification
Rapid wetting
Excellent polymerization stability
Low odor

Main Physical Properties[1]	
Active content, wt%	25
Appearance, 25℃	Pale yellow liquid
Diluent	Water
Critical micelle concentration (CMC), 25℃, ppm	175
Surface tension, 25℃ (1 wt% aqueous solution), mN/m	31
Ross Miles foam height, (0.2 wt% aqueous solution, initial/5 min), mm	130 / 105
pH, (1 wt% aqueous solution)	7-10
Wetting time, (0.5 wt% aqueous solution, 20℃, canvas settling method), sec	13
Specific gravity, 20℃	1.06
Viscosity, 20℃, cPs	140

1 Typical properties, not to be construed as product specification.

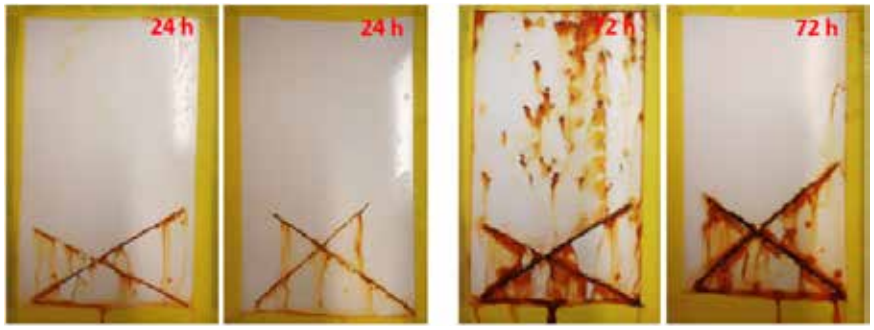
Application in emulsion polymerization

Product features	Benchmark	DOWFAX™ AS-321
Emulsifier dosage, phm	1.2	1.2
Solid content (% wt.)	45.4	46.0
pH	8.8	8.5
Particle size (nm)	92.5	87.6
Peak width (nm)	24.4	26.7
Calcium stability (5% $CaCl_2$, aq.)	< 1%	< 1%
Water whitening resistance (96 h, WWR), L	11.69	16.00

Note: the weight ratio of emulsifier in ME / Kettle is about 58/42.

Compared with the Benchmark, DOWFAX™ AS-321 has more outstanding performance on salt spray resistance, and both are quite good at early water resistance.

Salt spray resistance test

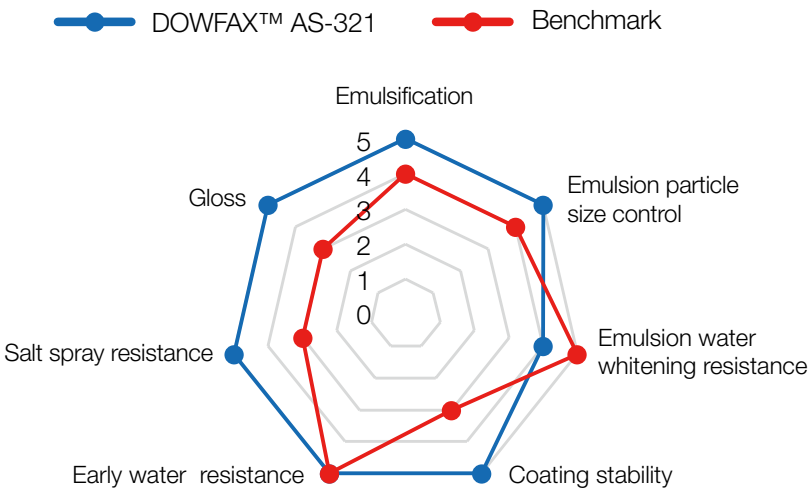


Benchmark DOWFAX™ AS-321 Benchmark DOWFAX™ AS-321

Early water resistance test

Benchark AS-321

Test method: dry for 75 minutes and soak in water for 24 hours;



Gloss

	Benchmark	DOWFAX™ AS-321
20°	9.8	22.4
60°	55.2	68.1
85°	88.6	92.2

In the application of waterborne metal coatings, the coatings prepared with DOWFAX™ AS-321 showed excellent gloss and better salt spray resistance, and the both shared similar early water resistance.

DOWFAX™ AS-906: Environmentally friendly sulfate emulsifier with high performance

DOWFAX™ AS-906 is a high performance environment friendly anionic emulsifier, specially developed for emulsion polymerization. Besides being environmentally friendly, DOWFAX™ AS-906 provides excellent emulsification, polymerization and formulation stability, rapid wetting, low foam and fast foam collapse. These advantageous properties help downstream users to improve the coating performance and stability, reduce application defects and increase production efficiency.

Product features
Environmentally friendly
Low foam and fast foam collapse
Rapid wetting
Excellent polymerization stability
Remarkable emulsion stability

Main Physical Properties[1]	
Active content, wt%	30
Appearance, 25℃	Colorless or pale yellow liquid
Diluent	Water
Critical micelle concentration (CMC), 25℃, ppm	320
Surface tension, 25℃ (1 wt% aqueous solution), mN/m	34
Ross Miles foam height, (0.2 wt% aqueous solution, initial/5 min), mm	125 / 10
pH, (1 wt% aqueous solution)	7.5
Wetting time, (0.5 wt% aqueous solution, 20℃, canvas settling method), sec	33
Specific gravity, 20℃	1.08
Viscosity, 20℃, cP	40

1 Typical properties, not to be construed as product specification.

Application in emulsion polymerization

Under the same process condition and same recipe, the performance of emulsions prepared with DOWFAX™ AS-906 and two similar products is compared below.

Emulsion performance test

The emulsion prepared with DOWFAX™ AS-906 provided excellent water whitening resistance, even better than the emulsion prepared with short EO chain anionic emulsifier, and it has much lower foam than the emulsions prepared with the other emulsifiers.

Emulsifier	DOWFAX™ AS-906	NP-4EO-sulfate	C10-5EO-sulfosuccinate
L (water emerged part[1])	22.54	25.27	25.58
L (above water[2]))	10.02	11.15	10.09
Foam height of emulsion (mm)[3]	42	59	55

1. *L*=0 indicates Black, and L=100 means While; the smaller the *L*, the better water whitening resistance.
2. The measurement is about 2 cm above the soaked part
3. Test method: high speed dispersion at 4000 rpm for 30 min

Evaluation in architectural coatings

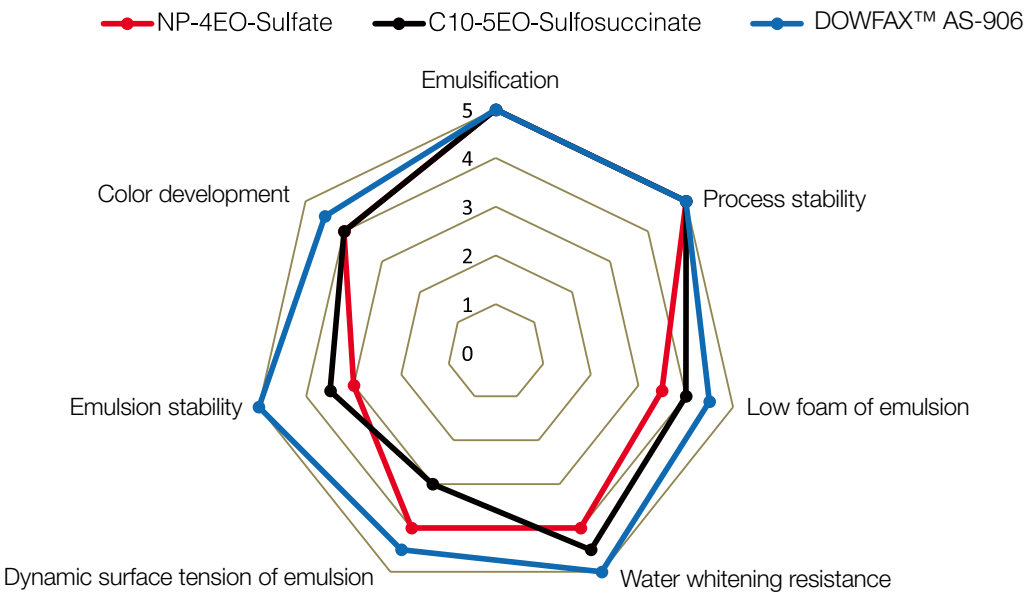
Color development test of coating[1]

Emulsifier	DOWFAX™ AS-906	NP-4EO-sulfate	C10-5EO-sulfosuccinate
ΔE (red)	0.253	0.303	0.447
ΔE (blue)	0.469	1.163	0.581
ΔE (black)	0.608	0.404	0.569
Total ΔE	1.330	1.870	1.597

1. PVC=80% and the coating recipe contains about 9.5 wt% emulsion.

The emulsion containing DOWFAX™ AS-906 showed excellent color development ability to red/blue color in the high PVC coating recipe. In summary, DOWFAX™ AS-906 is an anionic emulsifier with excellent color development.

Summary of performance test



Compared with the similar products on the market, DOWFAX™ AS-906 showed outstanding performance in emulsion polymerization and architectural coatings: low foam, better water whitening resistance, low dynamic surface tension and outstanding color development performance.

DOWFAX™ AS-801: Environmentally friendly sulfate emulsifier

Compared with the similar products on the market, DOWFAX™ AS-801 shows a series of notable advantages, such as excellent emulsion and formulation stability, rapid wetting, low surface tension, low foam and quick foam collapse, which helps downstream customers to increase production efficiency, improve product performance, and reduce coating defects.

Product features
Environmentally friendly
Quick wetting
Medium / low foam height
Quick foam collapse
Low surface tension

Main Physical Properties [1]	
Active content, wt%	50
Appearance, 25℃	Colorless or light yellow liquid
Diluent	Water
Critical micelle concentration (CMC), 25℃, %	0.2
Surface tension (1 wt% aqueous solution), 25℃, mN/m	32
Ross Miles foam height, (0.2 wt% aqueous solution, initial/5 min), mm	93 / 17
pH, (1 wt% aqueous solution)	7.5
Wetting time, (0.5% wt% aqueous solution, 20℃, canvas settling method), sec	3.0
Specific gravity, 20℃	1.08
Viscosity, 20℃, cP	350

1 Typical properties, not to be construed as product specification.

Other DOWFAX™ series

Non APE anionic emulsifiers

Main performance

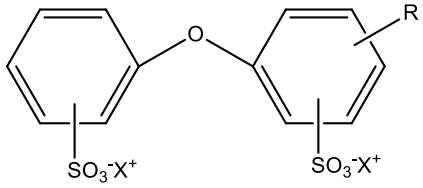
- Stable in strong acid and alkali
- Oxidation resistance
- Electrolyte resistance
- Good thermal stability
- Effective solubilization

Pure acrylic emulsion

- Effective particle size control
- High transparency of the film
- Heat resistance
- Good mechanical stability
- Less residue

Styrene-butadiene latex

- Effective particle size control
- Mechanical stability
- Storage stability



Alkyl diphenyloxide disulfonate

	DOWFAX™ 2A1	DOWFAX™ 8390
Appearance	Clear amber liquid	Clear amber liquid
Carbon chain	C12 branched chain	C16 linear chain
Active content wt%	45	35

According to the structure, every diphenyl ether molecule contains two polar sulfonate groups, indicating a higher charge density, which well explains why such a structure can provide outstanding emulsion stability.

Nonionic surfactant

TERGITOL™ CA series

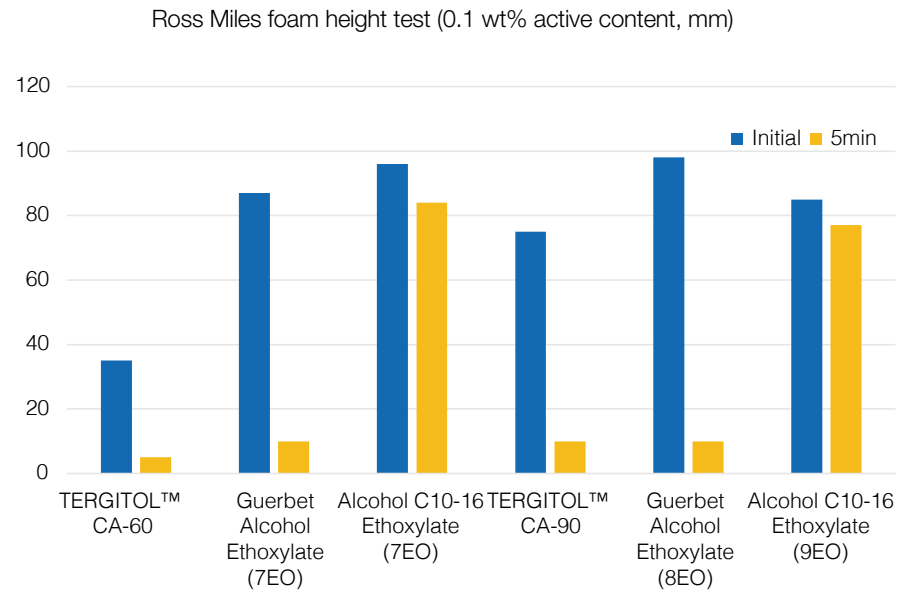
TERGITOL™ CA series are environment friendly nonionic surfactants with recognized quick foam collapse.

- Non APE surfactants
- Narrow gelatinization range
- Quick foam breaking
- Low odor
- Low aquatic toxicity
- Easy to operate
- Biodegradability

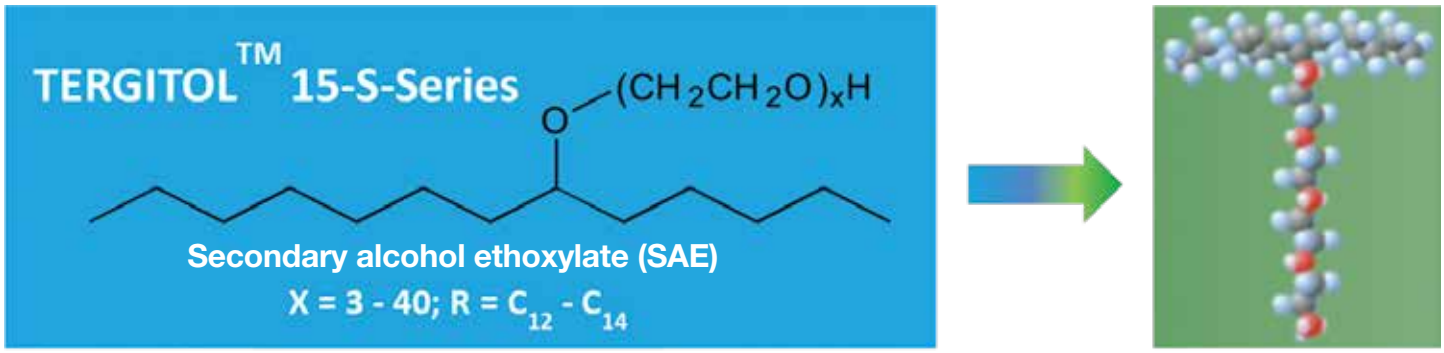
Physical Properties of TERGITOL™ CA series[a]

	TERGITOL™ CA-30	TERGITOL™ CA-60	TERGITOL™ CA-90	TERGITOL™ CA-90 (90%)
Cloud point (1 wt% aqueous solution, °C)	/	40	61	61
HLB	7.5-8.5	11-12	13-14	13-14
Surface tension (1 wt% aqueous solution, 25°C, mN/m)	29.5	29.5	30.5	30.5
Ross Miles foam height (1 wt% aqueous solution, initial/5 min, 25°C, mm)	0/0	35/5	75/10	75/10

Typical physical properties, not to be construed as product specification.



TERGITOL™ 15-S series



TERGITOL™15-S series nonionic surfactant, as a secondary alcohol ethoxylate product, exhibits excellent performance when replacing the linear primary alcohol polyoxyethylene ether (PAE) and APE surfactants in emulsion polymerization.

The outstanding performance of TERGITOL™ 15-S series nonionic surfactant in easy handling and formulation stability can be summarized as follows:

- Rapid dissolution (even at low temperature)
- Narrow gel range
- Good compatibility with other components in the formulation

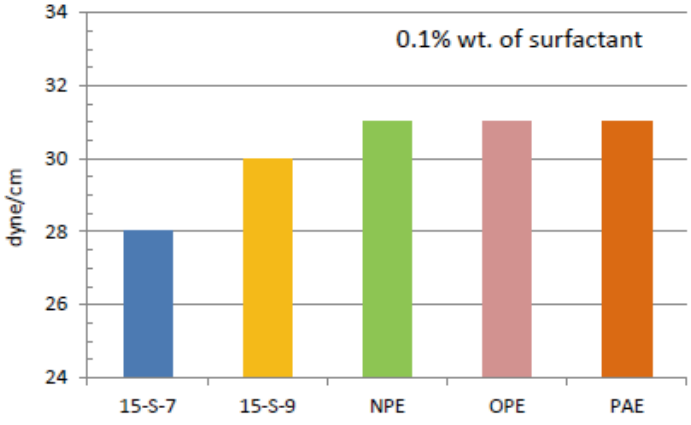
According to the test method of OECD 301F, TERGITOL™ 15-S series nonionic surfactant is biodegradable with low toxicity to aquatic environment; and it has excellent chemical stability in dilute acid, dilute alkali and salt. TERGITOL™ 15-S series nonionic surfactant is fully compatible with cationic, anionic and other nonionic surfactants, providing outstanding stability in the formula.

Product features	
Broad solvent compatibility	Easy handling
Quick foam collapse	Outstanding wetting ability
Readily biodegradable	

Main Physical Properties of TERGITOL™ 15-S series

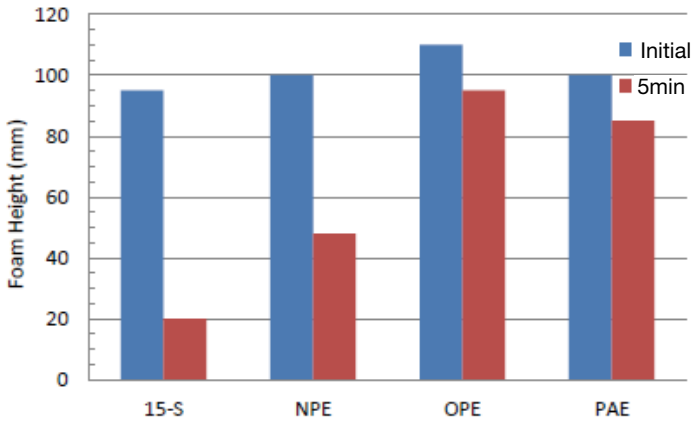
	15-S-9	15-S-12 (90%)	15-S-15	15-S-20 (80%)	15-S-30	15-S-30 (70%)	15-S-40 (70%)
Cloud point (1 wt% aqueous solution, °C)	60	89	>100	>100	>100	>100	>100
HLB	13.3	14.5	15.4	16.3	17.4	17.4	18
Pour point (°C)	9	-8	29	6	39	0	5
Active content (wt%)	100	90	100	80	100	70	70
Critical micelle concentration (ppm at 25°C)	52	107	162	315	558	558	1314
Surface tension (mN/m, 1 wt%, 25°C)	30	34	36	38	43	43	45
Ross Miles foam height (0.1 wt%, active content, initial/5 min, 25°C)	124/43	130/28	126/24	112/42	115/30	115/30	103/28

Static surface tension comparison



These selected surfactants share the similar EO chain length

Ross miles foam height comparison



The HLB value of the selected surfactants is around 13

Product features: low surface tension, quick foam collapse, wetting ability-20% better than that of NPE or PAE with similar EO chain length.

ECOSURF™ SA series

ECOSURF™ SA series products are a new generation of biodegradable non APE surfactants based on seed oil fatty alcohol. In addition of its excellent environmental profile, such nonionic surfactants have very low surface tension, quick wetting and low foam height.

Main performance indicators

	ECOSURF™ SA-7	ECOSURF™ SA-9	ECOSURF™ SA-15
Cloud point (1 wt% aqueous solution, °C)	37	57	>100
HLB	10-12	11-13	13-15
pH, 1 wt% aqueous solution	7.1	7.1	7.1
Appearance	Colorless to yellowish liquid	Colorless to yellowish liquid	White waxy solid
Pour point (°C)	4	4	27
Surface tension (1 wt%, 25°C, mN/m)	29	29	33.5
Critical micelle concentration (CMC) (ppm)	17	22	153

Product features
Excellent wetting
No gel range, quick dissolution
Broad HLB range

ECOSURF™ EH series

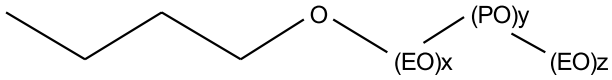
ECOSURF™ EH are environmentally friendly surfactants. According to OECD 301F test method, they are readily biodegradable with low aquatic toxicity EC50 > 10 mg/L. These surfactants have low foam and low odor, and they offer comparable performance as APE surfactants and better than that of linear primary alcohol ethoxylate (PAE) products.

Main performance indicators

	ECOSURF™ EH-6	ECOSURF™ EH-9	ECOSURF™ EH-14	ECOSURF™ EH-40
Cloud point (1 wt% aqueous solution, °C)	43	64	86	>100
HLB	10.8	12.5	14.2	18
Active content %	100	100	90	75
Appearance	Colorless to yellowish liquid	Colorless to yellowish liquid	Colorless to yellowish liquid	Colorless to yellowish liquid
Pour point (°C)	5	16	6	3
Surface tension, 1 wt% (mN/m)	30	31	32	46
	They are excellent wetting agents and effective emulsifiers, and can improve color development			It can be used as emulsifiers or post additives in all coating systems to improve freeze-thaw stability and calcium stability

TERGITOL™ X series

Butanol initiated EO / PO copolymer



Product features
Excellent emulsifier
Excellent dispersant for carbon black and pigments
Medium / low foam & quick foam collapse
Freeze-thaw stability effectively improved by steric hindrance
Thickening effect - viscosity increase due to hydrogen-bond interaction

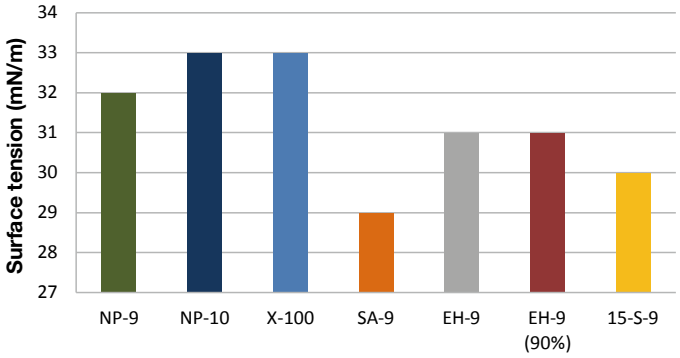
	TERGITOL™ XH	TERGITOL™ XD	TERGITOL™ XJ
Appearance / active content 25°C	White solid/100%	White solid/100%	White solid/100%
Cloud point (1 wt% aqueous solution, °C)	95	74	49
Pour point (°C)	40	34	27
HLB	14-15	13-14	12-13
pH, 1 wt% aqueous solution	7.1	7.1	7.1
Ross Miles foam height (0.1 wt%, 25°C, initial / 5 min)	80 / 40	60 / 25	53 / 13
Surface tension (1 wt%, 25°C, mN/m)	41	38	36

Dow solutions for APE nonionic surfactant replacement

Main Physical Properties

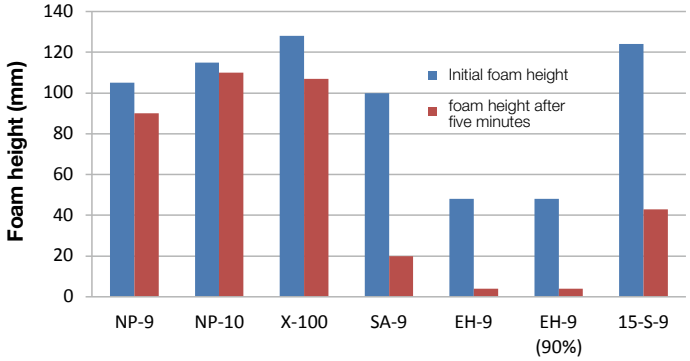
	TRITON™ NP-9	TRITON™ NP-10	TRITON™ X-100	ECOSURF™ SA-9	ECOSURF™ EH-9	ECOSURF™ EH-9 (90%)	TERGITOL™ 15-S-9
Cloud point (1 wt% aqueous solution, °C)	54	63	66	57	64	64	60
HLB	12.9	13.2	13.4	11-13	12.5	12.5	13.3
Pour point (°C)	-1	6	1	4	16	-5	9
Active content (%)	100	100	100	100	100	90	100
Critical micelle concentration (ppm, 25°C)	60	55	189	22	1066	1066	52
Surface tension (mN/m, 1 wt%, 25°C),	32	33	33	29	31	31	30
Ross Miles foam height (0.1 wt% active content, initial/5 min, 25°C)	105 / 90	115 / 110	128 / 107	100 / 20	48 / 4	48 / 4	124 / 43
Non-APE	no	no	no	yes	yes	yes	yes

Surface tension comparison



(1% active content, 25°C, mN/m)

Foam height comparison

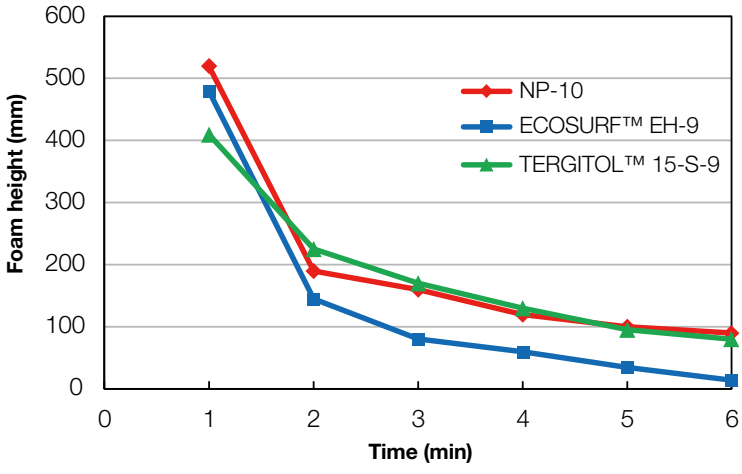


(Ross Miles foam height test method, 0.1% active content, 25°C)

Comparison with NP-10 in styrene acrylic emulsion polymerization

Nonionic emulsifier	NP-10	ECOSURF™ EH-9	TERGITOL™ 15-S-9
	Same dosage of DOWFAX™ AS-801 as anionic emulsifier		
Solid content (%)	48.6	47.5	48.2
Polymer residue (%)	0.12	0.10	0.10
Calcium stability	1/1 $CaCl_2$ Aqueous solution (10%)	1/1 $CaCl_2$ Aqueous solution (10%)	1/1 $CaCl_2$ Aqueous solution (10%)
Particle size (nm)	122.0	113.7	120.8

Emulsion foam height comparison



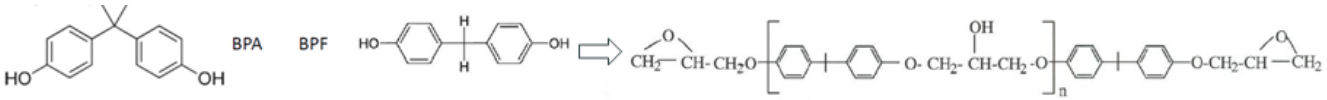
- Environmentally friendly nonionic ECOSURF™ EH-9 and TERGITOL™ 15-S-9 can provide similar performance as NP-10.
- The combination of ECOSURF™ EH-9 and DOWFAX™ AS-801 exhibits outstanding low foam in the emulsion.

Waterborne epoxy resin

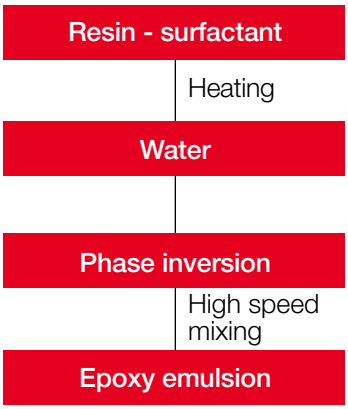
Epoxy resin features many excellent properties, such as great adhesion on the surface of metal, ceramics, glass, wood; outstanding chemical resistance and electrical insulation. Besides, the epoxy resin paint film containing aromatic ring and ether bond incorporates both rigidity and flexibility. These characteristics play an important role in multiple fields of applications such as flooring, adhesives, direct-to-metal primers, chemical resistance coatings, corrosion resistance coatings and others.

With the growing level of environmental awareness and introduction of new regulations, the waterborne epoxy resin has received more attention. Compared with solventborne epoxy resins, waterborne epoxy resins still need further improvement in application performance, batch quality consistency, and storage stability.

Structure of typical epoxy resin



Phase-transfer process



The phase-transfer process is an important technology in the synthesis of waterborne epoxy. In the phase-transfer process, surfactant and co-solvent play an important role in ensuring the stability and later application performance of the epoxy emulsion.

Co-solvent

The co-solvent can effectively lower the softening point of epoxy resin and play a role in reducing the resin viscosity for emulsification purpose. The co-solvent can also assist film formation, adjust drying rate and improve the appearance of paint film later in application. The chemical structure and quality of co-solvents have great impact on the stability of epoxy emulsion and application performance. Dow provides a series of co-solvent products with excellent performance and quality.

Typical co-solvent in epoxy emulsion

Product	Boiling point (°C)	Characteristics
DOWANOL™ PM	120	Strong solvency, effectively reduces the epoxy resin viscosity; fast drying; low content of isomer and other impurities, helps to achieve stable epoxy emulsion
DOWANOL™ PnP	149	Excellent solvency for epoxy resin; assisting film formation with less defects
Butyl CELLOSOLVE™	171	Strong solvency for epoxy resin Medium evaporation rate for better paint film appearance.
Propyl CELLOSOLVE™	151	Strong solvency and emulsifying capability for epoxy resin

Emulsifier

The selection of surfactants plays a vital role in the synthesis of epoxy emulsions. The right surfactants help improve emulsification efficiency, achieve ideal particle size, control particle size distribution, and have a great impact on storage stability and rheological properties. In addition, the effects on the performance of the paint film, such as salt spray resistance, water resistance, chemical resistance should be taken into account in the selection of surfactants.

Dow offers a range of nonionic and anionic emulsifiers with high HLB values.

Typical solid epoxy emulsion formulation (wt%)

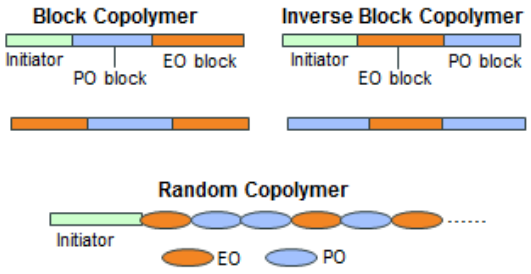
Component	Content
Epoxy resin	50%
DOWANOL™ PM	5%
DOWFAX™ 100N50	5%
Water	To 100%

Typical emulsifier for epoxy emulsion preparation

Product	HLB	Characteristics
TRITON™ X-405	17.6	Traditional OPE surfactants, general purposed emulsifier for epoxy and epoxy-acrylic hybrid systems
TERGITOL™ 15-S-40	18.0	Non-APE based nonionic surfactant; readily biodegradable; excellent emulsifying performance
DOWFAX™ 100N50	>18	Non-APE based highly efficient EO/PO block copolymer; used for emulsifying solid epoxy to help reduce emulsion particle size and improve emulsion stability
TERGITOL™ X series	12~15	Non-APE based EO/PO block copolymer with medium molecular weight; used for normal liquid epoxy
DOWFAX™ AS-321	>18	Phosphate surfactant, used together with non-ionic surfactants to improve emulsion stability

Polyether intermediates

Dow provides a series of polyether products based on ethylene oxide, propylene oxide and butylene oxide units, including block and random copolymers, which can be used as raw materials for epoxy resin surfactant preparation and epoxy resin modification.



Category	Product series	Characteristics
Polyethylene glycol series	CARBOWAX™ PEG, MPEG	Broad product offerings with molecular weight from 200 to 8000
Polypropylene glycol series	Polyglycol P DOWFAX™ DF SYNALOX™ 100 UCON™ LB	Broad product offerings with molecular weight from 400 to 6000
Block copolymer	TERGITOL™ L TERGITOL™ X DOWFAX™ DF, 100N50	EO/PO block copolymer covering a molecular weight range of hundreds to tens of thousands with different EO and PO ratios and the sequence of EO/PO blocks
Random copolymer	SYNALOX™ 40,50 UCON™ 50-HB, 75-H	EO/PO random copolymer, with stable product quality and batch stability, covering a molecular weight range of hundreds to tens of thousands
Allylic polyether	Polyglycol APEG-11 Polyglycol 40-HA-4000 Polyglycol 45-HA-3400 Polyglycol 50-HA-1200 Polyglycol 75-HA-750 Polyglycol 75-HA-1400	Reactive block polyether products, covering a molecular weight range of 500 to 4000 with low salt content.

Intermediates for Hardeners

Dow provides a wide range of ethyleneamine products, used for the synthesis of hardeners for epoxy resins.

Product	Structure	Appearance (25°C)	Freezing point (°C)	Boiling point (°C, 760mmHg)
EDA	Ethylenediamine	Liquid	11	117
DETA	DETA (diethylenetriamine)	Liquid	-39	207
TETA	TETA (triethylenetetramine)	Liquid	-35	277
TEPA	TEPA (tetraethylenepentamine)	Liquid	-46	288
AEP	Aminoethyl piperazine	Liquid	-17	221

Waterborne polyurethane resin

Polyurethane resins are characterized by excellent mechanical properties, abrasion resistance, toughness, protection, appearance and strong adhesion, which make them widely used in applications like wood paint, industrial coatings, marine and protective, automotive topcoats and others. Dow offers a series of products and technical solutions for the synthesis of waterborne polyurethane resins.

Dihydroxyl/polyhydroxyl polyether

Hydroxyl polyether is an important raw material for the synthesis of waterborne polyurethanes, and Dow offers a range of dihydroxyl and polyhydroxyl polyether products covering a wide range of molecular weight and EO/PO ratios to meet the needs of different applications. And Dow's polyether products have stable product quality and batch stability.

	Category	Product series	Description
Dihydroxyl polyether	Polyethylene glycol series	CARBOWAX™ PEG	Broad product offerings with molecular weight from 200 to 8000
	Polypropylene glycol series	Polyglycol P SYNALOX™ 100 DOWFAX™ DF	Broad product offerings with molecular weight from 400 to 6000
	Block copolyether	TERGITOL™ L DOWFAX™ 100N50 DOWFAX™ DF	EO/PO block copolymer, covering a molecular weight range of hundreds to tens of thousands with different EO and PO ratios, and the sequence of EO/PO blocks
	Random polyether	SYNALOX™ 40 UCON™ 75-H	EO/PO random copolymer, with stable product quality and batch stability, covering a molecular weight range of one thousand to tens of thousands
Polyhydroxyl polyether	Glycerol-initiated and sorbitol-initiated polyhydroxyl polyethers	DOWFAX™ DF series	Polyfunctional block copolymer products

Co-solvent

Dow provides a wide range of co-solvents used for the preparation of 1K and 2K waterborne polyurethane resins with excellent solvency to effectively reduce the viscosity of prepolymer.

	Product	Boiling point (°C)	Characteristics
Waterborne PUD/PUA	PROGLYDE™ DMM	175	It can dissolve DMPA as an alternative to NMP with low toxicity. It also has film-forming performance and helps improve the performance of later paint film.
Waterborne 2K PU	PROGLYDE™ DMM	175	Used for the synthesis of high hydroxyl acrylic polymer by secondary dispersion method with good solvency for prepolymer to effectively reduce the viscosity of prepolymer, and film-forming performance.
	DOWANOL™ PnB	171	
	DOWANOL™ PnP	149	

Diluent for hardener in waterborne 2K PU

Isocyanate hardener reacts with hydroxyl, amino and other groups containing active hydrogen, so the diluent of the hardener should be an aprotic solvent as required. Dow offers a wide range of solvents with excellent solubility for hardeners, controlled water content, a wider boiling point and evaporation rate to meet the needs of different application performance and conditions.

Product	Boiling point (°C)	Characteristics
DOWANOL™ PMA	146	General purposed hardener diluents, with good product quality and batch stability
DOWANOL™ PGDA	191	High solvency, low odor, low water content, helping extend the pot life.
PROGLYDE™ DMM	175	High solvency, low odor, low water content, fast film hardness establishment, good film transparency and gloss
Butyl CELLOSOLVE™ Acetate	192	Aprotic solvent with medium volatilization rate
Butyl CARBITOL™ Acetate	245	Aprotic solvents with slow evaporation rate, good for leveling and reducing paint film defects

Dow Industrial Solutions offers a wealth of surfactants, oxygenated solvents and polyether polyols that can meet your diverse demands for resin synthesis.

- DOWFAX™ environmentally friendly anionic emulsifiers AS-321, AS-906, AS-801, 2A1 and 8390 can meet your performance requirements in emulsion polymerization.
- ECOSURF™ SA and EH series as well as TERGITOL™ CA and 15-S series provide a variety of nonionic emulsifiers. As environmentally friendly emulsifiers, they have outstanding product characteristics, such as: low foam and low surface tension, etc.
- In the synthesis of waterborne epoxy resin, Dow oxygenated solvents, high HLB non-ionic and phosphate surfactants can be directly used in the synthetic process; many polyether polyols provide rich intermediates for the modification of epoxy resins; and ethyleneamine products can be used in the synthesis of hardeners.
- In the application of waterborne polyurethane, Dow's rich polyether polyols meet demand on a variety of design ideas and performance guarantees for resin synthesis. A variety of oxygenated solvents can ensure viscosity control in the synthesis process, and film formation and application performance of the coating for later use.

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