

who provides a
combination of
solvency and
surface activity?

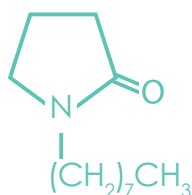
surfadone™ LP
specialty surfactants



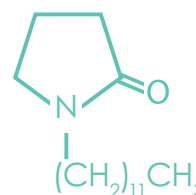
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product profile

Surfadone™ LP specialty surfactants are linear, N-alkyl-2-pyrrolidones with the following chemical structures:



Surfadone™ LP-100 surfactant



Surfadone™ LP-300 surfactant

Surfadone™ LP specialty surfactants combine the hydrophilic, dipolar pyrrolidone ring with a hydrophobic alkyl group and exhibit a unique combination of solvency and surface activity. They are multifunctional and provide a variety of performance benefits in a range of applications.

applications

- fountain solutions
- pigment dispersions
- photoresist strippers
- waterborne adhesives
- cleaners
- specialty cleaning

applications

lithographic dampening (fountain) solutions:

Surfadone™ LP-100 surfactant is currently the preferred surfactant technology for alcohol-free, continuous dampening systems¹² for web offset printing. Performance in such a dynamic process is determined by the speed with which the bulk surfactant influences the interface. The high dynamic surface activity of Surfadone™ LP-100 surfactant provides rapid wetting of the non-image area of the printing plate to ensure high print quality. Surfadone™ LP-100 surfactant also provides low foam, high flash points, and by minimization of ink build up, allows longer runs between clean up. Fountain solution concentrates typically incorporate 2-5% Surfadone™ LP-100 surfactant.

pigment dispersions: To help provide stable mill bases with high tinctorial strength, Surfadone™ LP-100 surfactant functions to enhance the wettability of organic pigments. At low use levels, Surfadone™ LP-100 surfactant permits high pigment loading with low viscosity and is particularly effective with phthalocyanine pigments.

photoresist strippers: In non-aqueous formulations, 10-20% Surfadone™ LP-100 surfactant is used as a co-solvent, usually in conjunction with M-Pyrol™ (N-methyl-2-pyrrolidone) and BLO™ (γ-butyrolactone), to enhance performance by broadening the solvency range.

performance features and benefits

- high surface activity at low concentrations
- rapid wetting
- low foam
- synergism with anionic surfactants
- excellent solvency
- good compatibility
- low flammability
- biodegradable

printed circuit board cleaners: In aqueous formulations, 1-2% Surfadone™ LP-100 surfactant enhances wetting of aluminum and Teflon® substrates, and facilitates removal of polymerized rosin residues.^{13, 14}

waterborne adhesives: Achieving acceptable adhesion as well as good flow and leveling in water-based systems requires the use of high-performance wetting agents. The low dynamic surface tensions possible through the use of Surfadone™ surfactants (specifically Surfadone™ LP-100 surfactant) support their use as high-performance, low-foaming wetting agents in these applications. The low hydrophilic-lipophilic balance (HLB) values of Surfadone™ surfactants indicate that they will not add to the water sensitivity of the finished product. For example, Surfadone™ LP-300 surfactant has been shown to optimize the spray pattern and improve adhesion of a chloroprene latex adhesive.¹⁵

specialty cleaning: In addition to providing high surface activity and wetting, Surfadone™ LP-100 and LP-300 surfactants combine a broad spectrum solvent capability with favorable safety features. Consequently, they are frequently safer alternatives to hazardous solvents and provide solvency for a wide range of organic materials and resins. In aqueous metal cleaners, 1-2% Surfadone™ LP-100 surfactant facilitates cleaning performance^{9, 10} and interacts with alkoxyated thiol surfactants¹¹ to minimize odor.

table 1: Surfadone™ LP surfactant properties (typical values)

properties ^{7, 18–29}	Surfadone™ LP-100 surfactant	Surfadone™ LP-300 surfactant
physical form (25°C)	liquid	liquid
purity (area % GC)	98 min.	98 min.
color (APHA)	100 max.	180 max.
moisture (%)	0.1 max.	0.1 max.
boiling point (°C)	100 @ 0.3 mm Hg	145 @ 0.2 mm Hg
flash point (°C) closed cup	113	116
freezing point (°C)	-25	10
vapor pressure (mm Hg @ 20°C)	<0.001 est.	<0.001 est.
density (g/cm ³ @ 20°C)	0.922	0.903
viscosity (m•Pas @ 20°C)	9	18
refractive index @ 25°C	1.471	1.466
dipole moment (Debye)	3.83	3.82
Hansen Solubility Parameters (J/cm ³) ^{1/2}	$\delta_T = 18.9$ $\delta_D = 16.9$ $\delta_P = 6.2$ $\delta_H = 5.8$	$\delta_T = 18.2$ $\delta_D = 16.9$ $\delta_P = 4.4$ $\delta_H = 5.0$
HLB	6	3
solubility in water (g/L @ 25°C)	0.124	0.02
biodegradable	Yes	Yes
molecular weight	197	253

solubility

Surfadone™ LP specialty surfactants are readily soluble in most organic solvents and exhibit unique solubility characteristics in water.

In aqueous solution at ambient temperature, single-phase systems are obtained with Surfadone™ LP-100 surfactant concentrations <0.124% and LP-300 concentrations < 0.002%.

As the concentration of Surfadone™ LP surfactant is increased, two phases separate until at 65% Surfadone™ LP-100 surfactant and 80% Surfadone™ LP-300 surfactant, a single phase is obtained.

As the temperature of two-phase systems is decreased, the solubility of both Surfadone™ LP-100 and LP-300 surfactant increases. Before the lower critical solution temperature (LCST) or cloud point can be reached, ice crystals form.

Surfadone™ LP-100 and LP-300 surfactants interact with anionic surfactants and are solubilized in aqueous solution to afford mixed micelles. Low-viscosity solutions of up to 8% Surfadone™ LP-100 surfactant and up to 4% Surfadone™ LP-300 surfactant may be obtained with 1-2% sodium dodecyl sulfate (SDS). Viscous solutions and gels are obtained with Surfadone™ LP-300 surfactant concentrations > 4%.

Surfadone™ LP specialty surfactants are also solubilized in water, although less efficiently, by water-miscible organic solvents – e.g., 30% propylene glycol is required to dissolve 3% LP-100.

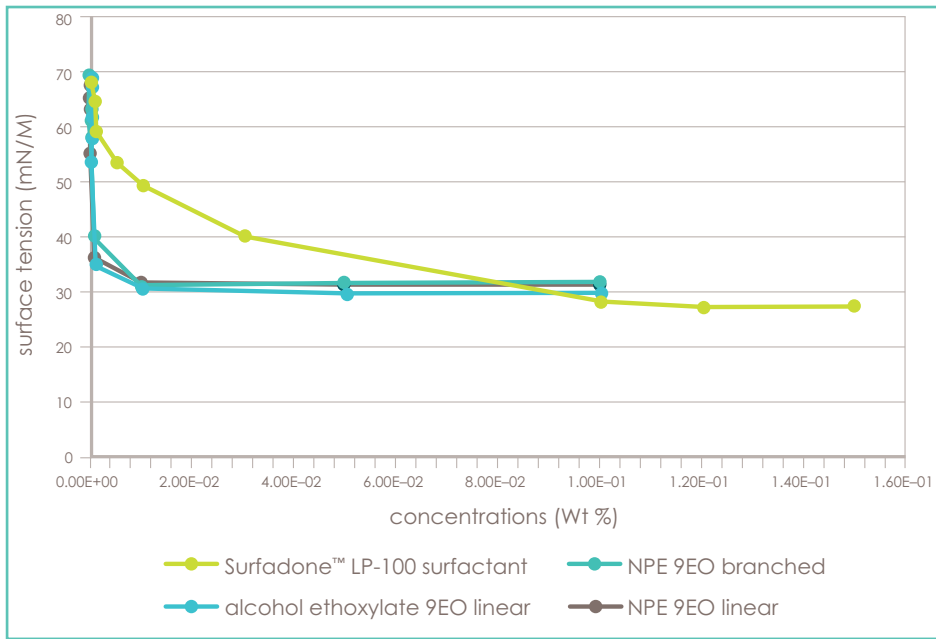
surface tension reduction, wetting & foaming

Both Surfadone™ LP-100 and LP-300 surfactants exhibit comparable effectiveness in reducing the static (equilibrium) surface tension of water and do not reach a critical micelle concentration (CMC). Surfadone™ LP-300 surfactant exhibits greater efficiency in static surface tension reduction than Surfadone™ LP-100 surfactant.

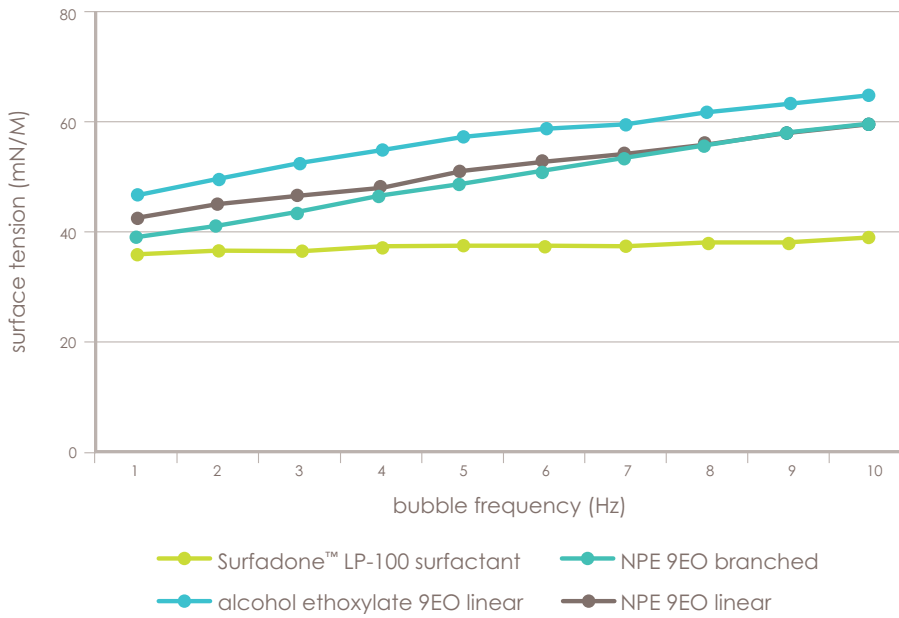
Dynamic surface tension is a measure of the kinetics of surfactant adsorption/orientation at the interface and may be correlated with wetting speed. Surfadone™ LP-100 surfactant is a more effective dynamic surface tension reducer/wetting agent than Surfadone™ LP-300 surfactant, which may be attributed to the greater solubility/mobility of Surfadone™ LP-100 surfactant in an aqueous environment. Anionic surfactants, such as SDS and linear alkyl benzene sulfonate (LAS) interact with Surfadone™ LP-100 and LP-300 surfactants to provide synergistic surface tension reduction and wetting enhancement. Surfadone™ LP-100 and LP-300 surfactants are low foaming, as determined by the Ross-Miles method. Mixtures of Surfadone™ LP-100 surfactant with SDS, at total surfactant concentrations of 0.1%, exhibit minor synergistic increases in foam height, although no synergism was observed with Surfadone™ LP-300 surfactant.

Surfadone™ LP specialty surfactants are compatible with cationic, nonionic and amphoteric surfactants. Surface tension (Graphs 1-3), Ross-Miles (Table 4) and Draves data (Graph 4 and Table 2) for Surfadone™ LP-100 and LP-300 surfactants are summarized.

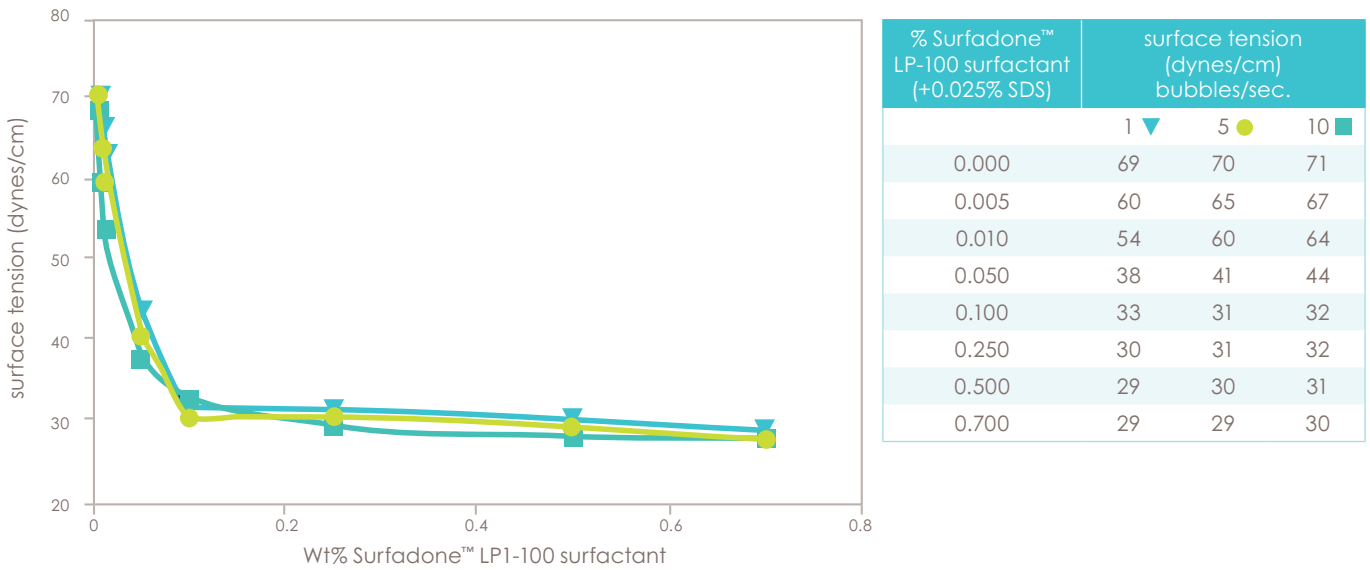
graph 1: static surface tension on various surfactants



graph 2: dynamic surface tension on various surfactants at 0.1% concentration

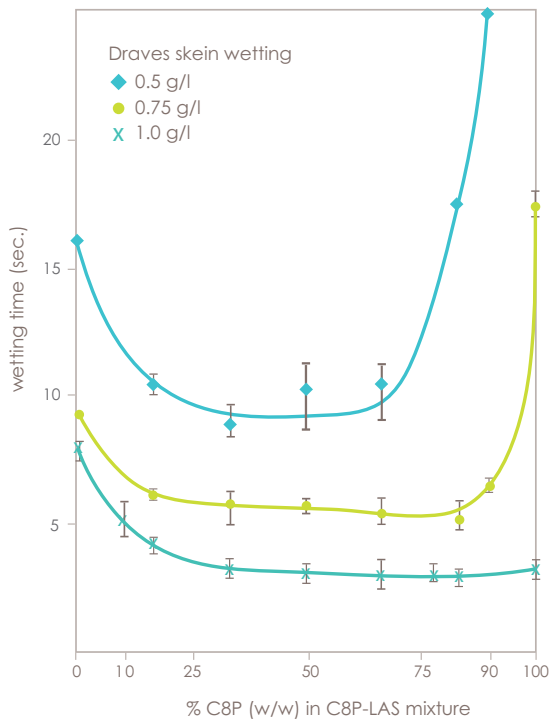


graph 3: dynamic surface tension of Surfadone™ LP-100 surfactant with sodium dodecyl sulfate^a



^a American Ink Maker, October 1994

graph 4: Draves wetting Surfadone LP-100 and sodium dodecyl sulfate



Draves skein wetting time vs. percentage of C8P in C8P-LAS mixtures at various total surfactant concentrations. JAOCS 66(7): 998-1001, 1989

table 2: Draves wetting at 0.1%, seconds^b

name	surfactant alone	1:1 blend with Surfadone™ LP-100 surfactant
Poloxamer 182	>300	41
Poloxamer 407	>300	48
Nonoxynol 30	>300	13
Dodecylphenol + 6EO	>300	44
Polysorbate 20	>300	33
Nonoxynol 9 Phosphate	142	20
sodium dodecyl diphenyl oxide disulfonate	103	11
Surfynol 104	12	—
LAS	9	instantly
Surfadone™ LP-100 surfactant	3.5	3.5

^b JAOCS 72: 759-771, 199

The wetting capability of Surfadone™ LP surfactants are also demonstrated by contact angle reduction on both high and low energy surfaces. Surfadone™ LP-100

surfactant is particularly effective on aluminum and representative data are summarized in table 3.

table 3: contact angles

	aluminum	silicone	polypropylene	teflon
water	84	95	95	113
Surfadone™ LP-100 surfactant (0.1% in water)	< 5	56	34	54
Surfadone™ LP-300 surfactant (0.1% in water)	36	53	33	54

foaming

Surfadone™ LP products are low foaming in aqueous solutions. The initial foam heights in Ross-Miles tests are 25mm and 13mm for Surfadone™ LP-100 and LP-300

surfactants respectively. The initial and five minute foam heights for Surfadone™ LP-100 and LP-300 surfactants mixed with SDS are shown in table 4 below.

table 4: Surfadone™ LP/SDS surfactant ratio

	pure	3:1	1:1	1:3
Surfadone™ LP-100 surfactant	25/5	159/159	164/161	58/157
Surfadone™ LP-300 surfactant	13/11	139/139	135/135	151/151
Sodium Dodecyl Sulfate (SDS)	156/156	—	—	—

Foam height (mm), initial/5 min. Total concentration, 0.1%

compatibility with plastics and elastomers

A study was conducted to quantify weight and dimensional changes of 15 plastics and elastomers exposed to 100% Surfadone™ LP products at ambient temperatures for seven (7) days. Of the substrates tested, polyethylene, polypropylene, nylon, Kynar*

(Pennwalt) and Teflon* (DuPont) have good resistance. Those that show poor resistance include EPDM-70, Lexan* (General Electric), Noryl* EN-265 (General Electric) and Viton* (DuPont). ABS fragmented within 24 hours and PVC dissolved in 48 hours.

table 5: Surfadone™ LP-100 surfactant at ambient temperature for 7 days % change

coupon	weight	length	width	thickness
ABS	coupons fragmented after 24 hours			
butyl rubber	12.48	3.23	0.39	3.23
EPDM-70	66.7	20.06	19.73	25.66
Kynar* (Penwalt)	0.58	0.19	0.32	2.13
Lexan* (GE)	coupons dissolved after 48 hours			
Noryl EN-265* (GE)	4.8	0.43	0.98	3.19
nylon	-0.4	-0.1	-0.19	0.07
polyethylene (XL)	0.15	0.03	0	0.24
polyethylene (LD)	0.02	0.42	1.4	0
polyethylene (HD)	0.25	0.07	-0.13	-0.88
polypropylene	0.08	0.2	0.33	0
polyvinyl chloride	coupons dissolved within 48 hours			
silicon rubber	17.6	5.16	7.4	6.7
Teflon* (DuPont)	0.01	0.07	0.26	0
Viton* (DuPont)	201.4	65.0	75.5	71.7

table 6: Surfadone™ LP-300 surfactant at ambient temperature for 7 days % change

coupon	weight	length	width	thickness
ABS		coupons fragmented after 24 hours		
butyl rubber	12.5	3.14	3.02	3.13
EPDM-70	66.7	6.67	19.73	24.0
Kynar® (Penwalt)	0.02	0.13	0	2.13
Lexan® (GE)	18.9	13.1	0.39	0.03
Noryl EN-265® (GE)	0.13	0.59	0.13	0.55
nylon	0.3	0.23	0.07	0
polyethylene (XL)	0.09	0.13	0.13	0.49
polyethylene (LD)	0.24	0.19	0.32	3.23
polyethylene (HD)	0.19	0.13	0.07	0.02
polypropylene	0.10	0.03	0.26	0.53
polyvinyl chloride		coupons dissolved within 48 hours		
silicon rubber	9.7	2.05	11.09	5.52
Teflon® (DuPont)	4.68	0.07	-0.2	3.12
Viton® (DuPont)	197.9	64.5	76.0	77.2

handling and storage

Surfadone™ LP specialty surfactants are corrosive and can cause severe eye and skin burns. Normal good practices should be followed. Wear goggles and impervious gloves. In case of accidental contact with skin or eyes, wash area immediately with water. Refer to the SDS for more detailed information.

Surfadone™ LP specialty surfactants are available in tank wagon and tank car quantities, as well as various-size phenolic-lined drums. For bulk storage, unloading and handling, it is recommended that (304 or 316) stainless steel storage tanks, pumps and piping and Teflon® gaskets and seals be used. Rubber hosing is not recommended.

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