

TERGITOL™ SENTRY™
15-S-9 Surfactant:

A High Performing, High Purity Surfactant
for Biopharmaceutical Processes



Table of Contents

- | | |
|-----------------------------|---|
| 1. Product Overview | 4. Efficient Downstream Detergent Removal |
| 2. Effective Cell Lysis | 5. Quality Statement: Compendial vs. Non-compendial |
| 3. Rapid Viral Inactivation | 6. References |

TERGITOL™ SENTRY™ 15-S-9 Surfactant

TERGITOL™ SENTRY™ 15-S-9 Surfactant is a high-purity, readily biodegradable nonionic alcohol ethoxylate surfactant for evaluation in biopharmaceutical manufacturing steps that require controlled membrane disruption.

The primary use concepts are cell lysis and detergent-mediated inactivation of enveloped viruses, followed by removal through downstream processing. TERGITOL™ SENTRY™ 15-S-9 Surfactant can be evaluated as a candidate detergent for cell lysis for recovery of intracellular proteins, plasmid DNA, viral vectors, vaccines, and more.

TERGITOL™ SENTRY™ 15-S-9 Surfactant is highly effective at viral inactivation across many types of processes, especially for enveloped viruses. TERGITOL™ SENTRY™ 15-S-9 Surfactant is a safer alternative to TRITON™ X-100 Surfactant.

Key Performance Attributes

- Effective lysis of cell membranes
- Rapid viral inactivation (>4 Log Reduction Value in under 5 minutes at 17 °C)
- Easily removed in downstream processing
- Minimal impact on API stability and manufacturing processes
- Suitable for use in lysis buffers for diagnostic tests¹
- Safer alternative to TRITON™ X-100 Surfactant

Key Product Properties

- High purity, manufactured under cGMP conditions
- Sourced from a facility managed under ISO 9001
- No risk of nitrosamine formation
- Low aldehyde and peroxide levels
- Low residual ethylene oxide and 1,4-dioxane levels
- REACH-compliant
- Readily biodegradable (OECD 301E)
- Possible participation Dow low carbon program
- Manufactured in the USA
- Transparent liquid
- CASRN: 84133-50-6



Quality Specification

Property	Specification
1,4-Dioxane	≤ 0.0001% (≤ 1 ppm)
Ethylene Oxide	≤ 0.0001% (≤ 1 ppm)
Acetaldehyde	≤ 0.0005% (≤ 5 ppm)
Ethylene Glycol	≤ 0.0500% (≤ 500 ppm)
Water	≤ 0.500% (≤ 5000 ppm)
Spectrophotometric Peroxide Assay	≤ 3,500 μM
cGMP	Yes

Typical Performance Properties

Property	Unit	Result
Actives	wt%	100
Cloud Point ¹	°C	60
HLB ²		13.3
Moles EO		9
Pour Point ³		9
Appearance		Clear to Pale Yellow Liquid
pH, 1% Aq Solution		7.1
Viscosity at 25 °C (77 °F)	cP	60
Density at 20 °C (68 °F)	g/mL	1.006
Flash Pt, Closed Cup, ASTM ⁴ D93	°C (°F)	193 (380)

1. Cloud point: °C, 1 wt% actives aqueous solution

2. HLB Range: < 10 w/o emulsifier, > 10 o/w emulsifier, 10–15 good wetting, 12–15 detergents

3. Pour point: °C

4. ASTM: American Society for Testing and Materials

Typical Physical Properties

Property	Unit	Result
CMC ¹	ppm	52
Surface Tension ²	mN/m	32
Foam Height ³	mm	124/43
Draves 20 Sec Wetting Conc at 25 °C (77 °F) at 50 °C (122 °F)	wt%	0.06 0.05

1. Critical Micelle Concentration: ppm at 25°C

2. Surface tension: dynes/cm at 1% actives, 25°C

3. Ross-Miles foam height: mm at 0.1 wt% actives, 25°C, initial / 5 minute

Effective Cell Lysis

Industrial Need

Protein stability and **bioprocess yield** are two of the most important performance indicators for a viable, safe and scalable biopharmaceutical process.

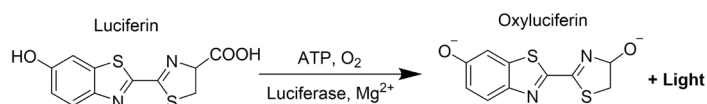
When using host cells where the active pharmaceutical ingredient (API) remains behind the membrane, a nonionic surfactant may solubilize membrane lipids and facilitate release of the target into the process stream for clarification and capture. Example materials to be purified include plasmid DNA, some recombinant proteins, viral vectors, virus-like particles, intracellular vaccine antigens, and other intracellular biologics.

The below results show that TERGITOL™ SENTRY™ 15-S-9 Surfactant is a more efficient cell lysing surfactant than TRITON™ X-100 Surfactant.

E. coli was used as a model system to study the kinetics of cell lysis. Some commercial biopharmaceuticals produced by *E. coli* that require cell lysis for purification include recombinant human insulin (Humulin), antibody fragments like Lucentis (ranibizumab), and enzymes like calaspargase pegol.²

Method

E. coli (ATCC 8739) was cultivated at 37 °C via standard practices in Tryptic Soy Broth (TSB) prior to introduction of detergent candidates for cell lysis. The kinetics of cell lysis were monitored by measuring adenosine triphosphate (ATP) concentration after introduction of a candidate detergent over 12 hours. ATP was quantified using a Luciferase fluorescence assay (Cell Titer-Glo® Substrate + lysing agent) measured using a BioTek Cytation 5 multimode imaging plate reader (Scheme 1). ATP can be detected if a cell is lysed and ATP is released into the buffer. ATP concentration will reach a plateau and begin to decline when complete cell lysis occurs. A buffer-only control was included to monitor non-surfactant-mediated cell lysis.



Scheme 1. Luciferase assay used to quantify ATP. Luciferase uses ATP to activate and oxidize luciferin releasing energy as a bright yellow-green light (~560 nanometers).

Results

Figure 1 shows that TERGITOL™ SENTRY™ 15-S-9 Surfactant is a more efficient cell lysing surfactant for *E. coli* than TRITON™ X-100 Surfactant. At 0.01 wt%, TERGITOL™ SENTRY™ 15-S-9 Surfactant reaches complete lysis as evidence by the plateau in ATP detected. By contrast, the concentration of ATP continues to increase for cells treated with TRITON™ X-100 Surfactant over the 12 hours.

TERGITOL™ SENTRY™ 15-S-9 Surfactant lyses *E. coli* similarly to TRITON™ X-100 Surfactant at higher detergent concentrations of 1.00 or 0.10 wt%.

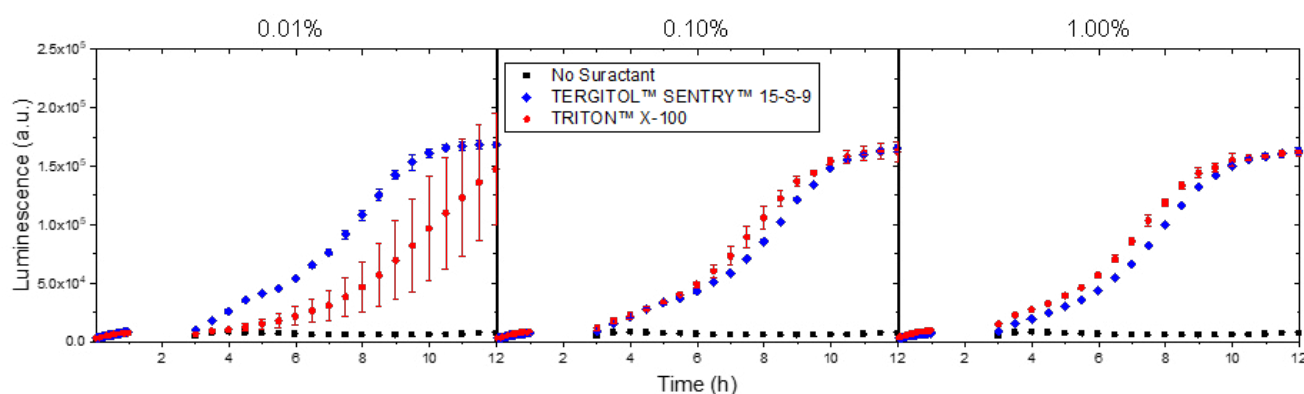


Figure 1. Shows that TERGITOL™ SENTRY™ 15-S-9 Surfactant is a more efficient cell lysing surfactant for *E. coli* than TRITON™ X-100 Surfactant at 0.01 wt%. At this condition, TERGITOL™ SENTRY™ 15-S-9 Surfactant is above the CMC, whereas TRITON™ X-100 Surfactant is below the CMC indicating CMC is a critical concentration for cell lysis. TERGITOL™ SENTRY™ 15-S-9 Surfactant lyses *E. coli* similarly to TRITON™ X-100 Surfactant at higher detergent concentrations of 0.10 or 1.00 wt%.

Rapid Viral Inactivation

Industrial Need

Patient safety requires viral inactivation in a biopharmaceutical manufacturing process. Thus, viral inactivation is a critical process step.

Detergent-mediated viral inactivation is based on the interaction of surfactant molecules with the viral lipid envelope. Effective treatment disrupts the envelope and prevents the virus from entering host cells. Efficacy depends on the virus, matrix, surfactant concentration, temperature, pH, mixing, contact time, and subsequent sample handling.

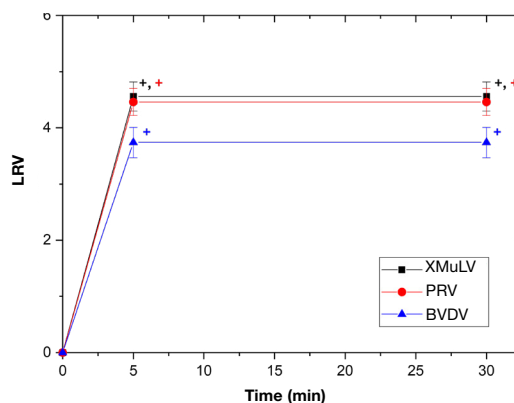
The below results show that TERGITOL™ SENTRY™ 15-S-9 Surfactant rapidly inactivates viruses of interest to biopharmaceutical manufacturing processes and is as effective as TRITON™ X-100 Surfactant.

Method

Xenotropic Murine Leukemia Virus (XMuLV), Pseudorabies virus (PRV), and Bovine Viral Diarrhea Virus (BVDV) were used as model viruses for detergent-mediated viral inactivation studies. The model harvest matrix was immunoglobulin G (IgG) for XMuLV and PRV or cryo-poor plasma for BVDV. TERGITOL™ SENTRY™ 15-S-9 Surfactant or TRITON™ X-100 Surfactant were introduced at concentrations of 0.5 or 1.0 wt% and the kinetics of viral inactivation were studied by performing a Tissue Culture Infectious Dose 50% (TCID50) assay. The log reduction value (LRV) was measured initially after 5 or 30 minutes of incubation with the detergent.

Results

Figure 2 shows that TERGITOL™ SENTRY™ 15-S-9 Surfactant rapidly inactivates all 3 model viruses tested at 17 °C. Over 4 LRV was achieved for XMuLV and PRV viruses within 5 minutes of introducing the detergent. Figure 3 shows equivalent viral safety performance for TERGITOL™ SENTRY™ 15-S-9 Surfactant and TRITON™ X-100 Surfactant.



+: No virus detected; values represent minimum LRV

Figure 2. Kinetics of TERGITOL™ SENTRY™ 15-S-9 Surfactant-mediated inactivation of Xenotropic Murine Leukemia Virus (XMuLV), Pseudorabies virus (PRV), or Bovine Viral Diarrhea Virus (BVDV). Matrix: IgG (XMuLV or PRV) or Plasma (BVDV); Temperature: 17 °C; Detergent dosage: 1.0%. The results show rapid inactivation of all three model viruses by TERGITOL™ SENTRY™ 15-S-9 Surfactant.

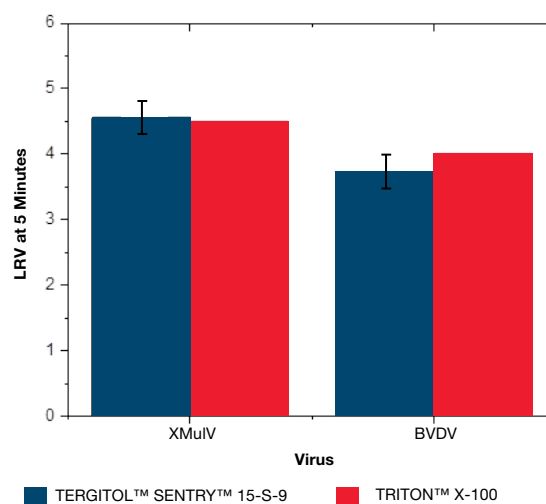


Figure 3. Equivalent viral safety performance of TERGITOL™ SENTRY™ 15-S-9 Surfactant and TRITON™ X-100 Surfactant. The results show similar inactivation of XMuLV and BVDV by both detergents. Temperature: 15 or 17 °C; Detergent dosage: 1.0%. TRITON™ X-100 Surfactant inactivation data reproduced from reference 3 with copyright permission.

Efficient Downstream Detergent Removal

Industrial Need

For patient safety, detergents deployed for viral inactivation or cell lysis must be removed from biopharmaceutical manufacturing processes by downstream separations before formulation of the final drug product.

Biopharmaceutical manufacturers need detergents that not only perform effectively during viral inactivation and cell lysis but can also be efficiently removed during downstream purification. Residual detergent levels must be tightly controlled to support product purity, patient safety, and regulatory compliance. An ideal detergent should integrate seamlessly into existing purification workflows without binding to chromatography resins or complicating process development.

The below results show that TERGITOL™ SENTRY™ 15-S-9 Surfactant is efficiently removed using representative downstream purification platforms employed in biopharmaceutical manufacturing, including affinity, cation-exchange, and anion-exchange chromatography

Method

The detergent removal was assessed using representative downstream purification platforms commonly employed in biopharmaceutical manufacturing, including affinity, cation-exchange, and anion-exchange chromatography. The resins and buffers used in the downstream purification studies are summarized below. Buffer systems and operating conditions were selected based on manufacturer-recommended protocols. Experiments were performed under protein-free conditions to directly evaluate detergent interactions with representative chromatography resins and assess their suitability for downstream purification processes.

Chromatography Resins	Purification Steps	Buffers
Protein A (Affinity) Eshmuno® A, MilliporeSigma	Binding & washing	25 mM Tris, pH 7
	Elution	50 mM glycine, pH 3
	Clean-in place (CIP)	150 mM H ₃ PO ₄
Cation Exchange (CEX) Eshmuno® CPX, MilliporeSigma	Binding & washing	20 mM phosphate, pH 6
	Elution	20 mM phosphate, 1 M NaCl, pH 6
	Clean-in place (CIP)	1 M NaOH
Anion Exchange (AEX) Fractogel® EMD TMAE Hicap, MilliporeSigma	Binding & washing	50 mM Tris, pH 9
	Elution	50 mM Tris, 1 M NaCl, pH 9
	Clean-in place (CIP)	1 M NaOH

Detergent levels were evaluated throughout purification steps, with residual concentrations quantified using a liquid chromatography–mass spectrometry (LC-MS) method capable of trace-level detection. Details of the LC-MS method used to quantify residual detergent at trace levels are provided below.

Chromatographic conditions:

Chromatography Resins	Purification Steps
LC system	Agilent Technologies 1260 Infinity
Column	Agilent EclipsePlus C18 RRHD 1.8 µm 2.1×50 mm
Mobile phase A	water + 5 mM ammonium formate + 0.1% formic acid
Mobile phase B	95% acetonitrile + 5% water + 5 mM ammonium formate + 0.1% formic acid
Flow rate	0.5 mL/min
Injection volume	5 µL

Gradient

Time (min)	% Mobile Phase B	Column Outlet
0	10	Waste
1	10	Waste
1.1	60	Waste
3	60	Waste – MS
5	100	MS
8	100	MS
8.1	10	MS – Waste
10	10	Waste

Mass spectrometry parameters:

MS instrument	Agilent Technologies 6470 Triple Quad
Polarity	Positive
Nebulizer Pressure	35 psi
Drying Gas	350 °C at 12.0 L/min
Capillary Voltage	3000 V
SIM Ion (m/z)	600.5, 614.5, 628.5
Gain EMV	1
Fragmentor voltage	70
Dwell time	115

Results

The detergent exhibited excellent compatibility with representative chromatography resins, with minimal retention observed across affinity, cation-exchange, and anion-exchange purification platforms. Quantitative LC-MS analysis confirmed that the detergent was fully recovered in the binding & washing flowthrough fractions, with no detectable detergent present in elution or CIP fractions. These results demonstrate efficient detergent removal during downstream processing.

Chromatography Type	Resin	Detergent Removal
Affinity (Protein A)	Eshmuno® A	100%
CEX, pH 6	Eshmuno® CPX	100%
AEX, pH 9	Fractogel® EMD TMAE Hicap	100%

A sensitive LC-MS method operated in selected ion monitoring (SIM) mode was developed for detergent quantification. The detergent produced three characteristic chromatographic peaks, each suitable for quantitative assessment. The first peak was selected for calibration and quantification as an example shown below. The method enabled trace-level detection with a limit of quantification (LOQ) of 0.1 ppm, supporting highly sensitive monitoring of residual detergent throughout downstream processing. Analytical measurements were performed using triplicate samples to ensure data reliability and reproducibility.

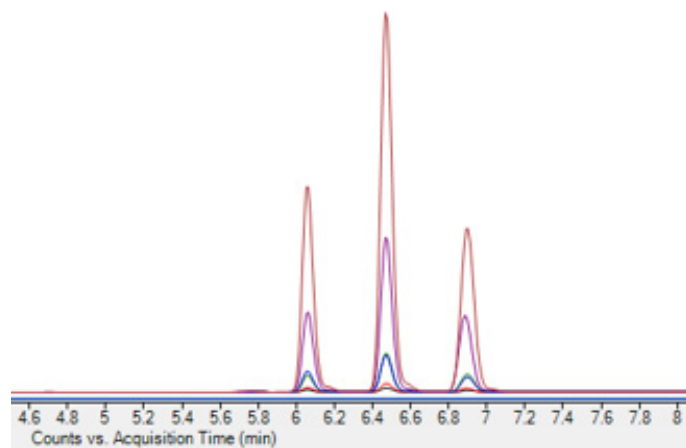


Figure 4. Overlay of LC-MS chromatograms acquired in selected ion monitoring (SIM) mode for Tergitol™ SENTRY™ 15-S-9 Surfactant standards ranging from 0.1 to 5 ppm. Three distinct chromatographic peaks were observed, all suitable for quantitative analysis.

Concentration (ppm or µg/mL)	Integrated Peak Area
0.1	61862
0.2	128642
0.5	446431
2	2107796
5	5434290

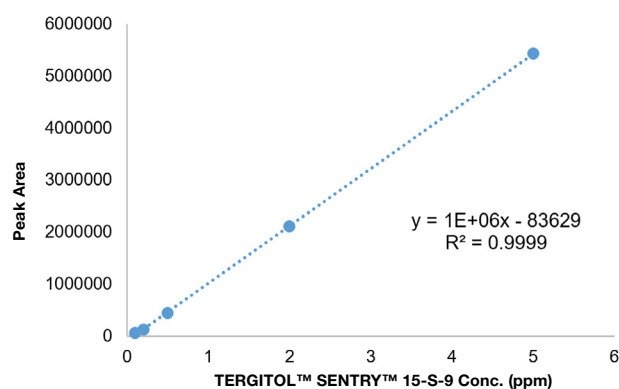


Figure 5. Calibration curve for Tergitol™ SENTRY™ 15-S-9 Surfactant standards ranging from 0.1 to 5 ppm.

Quality Statement

While TERGITOL™ SENTRY™ 15-S-9 Surfactant (CASRN 84133-50-6; Alcohols, C12-14-secondary, ethoxylated) is not a compendial material and has no pharmacopeial monograph, Dow produces TERGITOL™ SENTRY™ 15-S-9 Surfactant under stringent manufacturing and quality control standards in an ISO 9001:2015-certified facility. This product has well-defined specifications and key impurity limits which are maintained at levels equal to or lower than those commonly accepted for compendial nonionic surfactants. Impurities examples include ethylene oxide (<1 ppm) and 1,4-dioxane (<1 ppm).

References

1. Zorzoli, Azul, Alasdair MacLean, Scott Nicholson, Alison Daniels, Stephen Hughes, Susan Bennet-Slater, Christine Tait-Burkard, Noha El Sakka, Rory Gunson, and Kate Templeton. "Transitioning from Triton X-100 to Tergitol 15-S-9: impacts on diagnostic assays using viral PCR sample solution." *Biotechniques* 76, no. 7 (2024): 295-298.
2. Baeshen, Mohammed N., Ahmed M. Al-Hejin, Roop S. Bora, M. M. Ahmed, H. A. Ramadan, Kulvinder S. Saini, Nabih A. Baeshen, and Elrashdy M. Redwan. "Production of biopharmaceuticals in E. coli: current scenario and future perspectives." *J Microbiol Biotechnol* 25, no. 7 (2015): 953-962.
3. Banerjee, Kakolie, Alice Antonello, Sandra Johnson, Anja Licht, Almut Rapp, and Corinne Miller. "Demonstrating the Effectiveness of an Alternative to Triton X-100 for Detergent-Mediated Viral Inactivation in Biomanufacturing." *Biotechnology and Bioengineering* 122, no. 5 (2025): 1087-1095.

NOTICE: No freedom from infringement of any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other government enactments. The product shown in this literature may not be available for sale and/or available in all geographies where Dow is represented. The claims made may not have been approved for use in all countries. Dow assumes no obligation or liability for the information in this document. References to "Dow" or the "Company" mean the Dow legal entity selling the products to Customer unless otherwise expressly noted. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

®™ Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

© 2026 The Dow Chemical Company. All rights reserved.

2000058940-1397700

Form No. 971-00119-01-0926 S2D