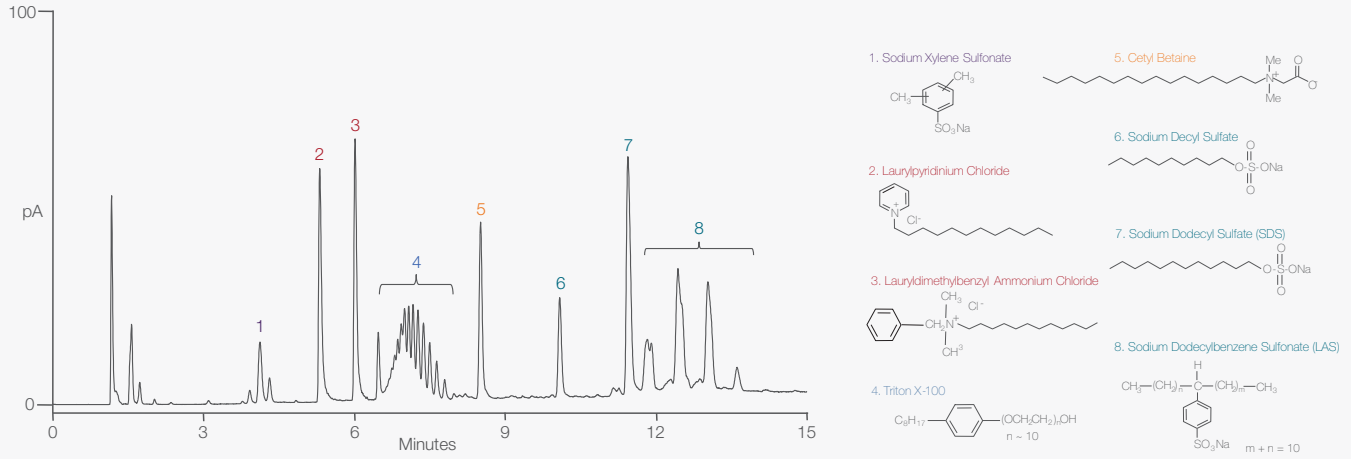
Acclaim Surfactant Plus column

Performance, versatility, throughput

The Thermo Scientific™ Acclaim™ Surfactant Plus column is a state-of-the-art, high-efficiency, silica-based, HPLC column designed for the determination of different types of surfactants, including anionics, nonionics, cationics, and amphoterics, in a wide range of samples, such as consumer products, pharmaceuticals, food and beverages, and environmental.

Simultaneous separation of cationic, nonionic, amphoteric and anionic surfactants



Column features

- Ideal selectivity for simultaneous separation of anionic, nonionic, cationic, and amphoteric surfactants
- Well-suited for the determination of cationic surfactants
- Excellent resolution for ethoxylated surfactants
- Capable of retaining highly hydrophilic compounds, such as hydrotropes
- Compatible with various detection methods, including charged aerosol detection, mass spectrometry (MS), evaporative light scattering detection (ELSD), suppressed conductivity detection (SCD), UV-Vis detection (UV).

Ideal selectivity for simultaneous separation of anionic, nonionic, cationic and amphoteric surfactants

Surfactants are widely used in industrial, agricultural, and pharmaceutical markets, in products as diverse as pesticides, detergent powders, petroleum products, cosmetics, and pharmaceuticals. Their separation and identification can be challenging due both to the diversity of surfactants and complexity of the sample matrix. Although many HPLC columns are available and have been used for the analysis of surfactant formulations, none of these columns have been designed specifically for this application, nor are they capable of separating anionic, nonionic, cationic and amphoteric surfactants in a single analysis.

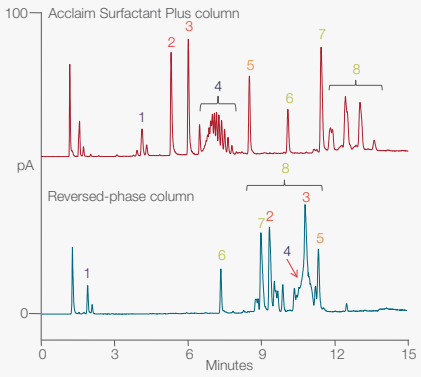
ThermoFisher SCIENTIFIC

The Acclaim Surfactant Plus column, based on novel mixed-mode chromatography technology and advanced surface chemistry, provides both reversed-phase and anion-exchange retention mechanisms. The column chemistry is designed in such way that it elutes in the order of cationic, nonionic, amphoteric and anionic surfactants. Figure 1 shows the Acclaim Surfactant Plus column provides ideal selectivity for simultaneous separation of these surfactants, whereas the C18 column fails to resolve them under the same condition.

Well-suited for the determination of cationic surfactants

Cationic surfactants are widely used as corrosion inhibitors, fabric softeners, and antimicrobial agents. The most popular cationic surfactants include alkyl quaternary ammonium, benzylalkylammonium, alkyl pyridinium, and alkyl imidazolium salts. When analyzing cationic surfactants, using a reversed phase C18 column, it is often difficult to obtain sharp, symmetrical peaks due primarily to the strong undesired ion-exchange interaction between the surface silanols and quaternary analytes. To improve the peak shape of a cationic surfactant, a high concentration of salt (such as perchlorate) is added to the mobile phase, which causes the analytical method to be incompatible with MS detection.

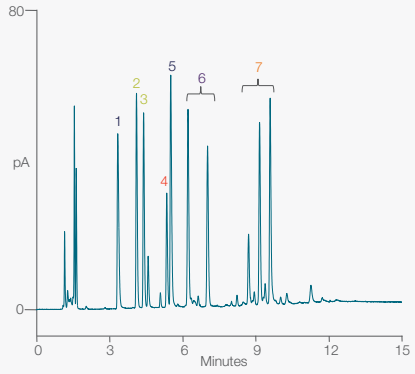
The surface chemistry of Acclaim Surfactant Plus column effectively deactivates the surface silanol activity so that cationic surfactants elute as symmetrical and efficient peaks compared to those obtained on the reversed-phase columns. The advanced surface modification process also ensures hydrolytically stable and reproducible surface, resulting in excellent compatibility with MS, charged aerosol detection and SCD. Figures 2 and 3 demonstrate the separations on an Acclaim Surfactant Plus column for mixtures of cationic surfactants and alkyl quaternary amines with excellent resolution and symmetrical peaks.



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	5 µL
Detection	Thermo Scientific™ Corona™ *ultra* RS™ Charged Aerosol Detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Peaks	(100-400 µg/mL each) 1. Xylene sulfonate 2. Laurylpyridinium 3. Lauryldimethylbenzyl ammonium 4. Triton X-100 5. Cetyl betaine 6. Decyl sulfate 7. Dodecyl sulfate 8. Linear alkylbenzene sulfonate (LAS)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
15	80	20

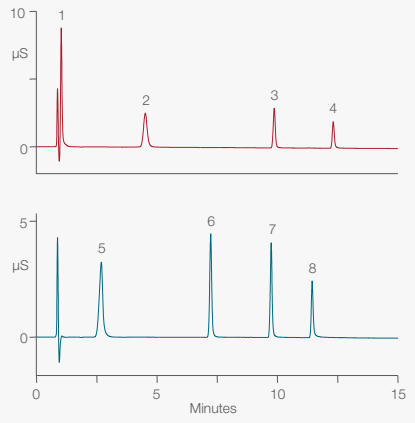
Figure 1. Simultaneous separation of cationic, nonionic, amphoteric and anionic surfactants



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	5 µL
Detection	Corona *ultra* RS Charged Aerosol Detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Peaks	(200-400 µg/mL each) 1. Lauryl pyridinium 2. Lauryldimethylbenzyl ammonium 3. Octylphenoxyethoxyethyl-dimethylbenzyl 4. Cetyltrimethylammonium 5. Cetylpyridinium 6. Diethyl heptadecyl imizolinium 7. Dimethyldihydrogenated tallow ammonium (2M2HT)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	35	65
0	35	65
8	85	15
15	85	15

Figure 2. Separation of cationic surfactants



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
System	ICS 3000
Mobile phases	A: Acetonitrile; B: 100 mM Formic acid; C: Water
Temperature	25 °C
Flow rate	0.5 mL/min
Inj. volume	5 µL
Detection	Conductivity with blank subtraction
Suppressor	CSRS300-2mm (external water 1.0 mL/min, current = 8 mA)
Peaks	1. Tetrabutylammonium 2. Tetrabutylammonium 3. Tetrahexylammonium 4. Tetraheptylammonium 5. Decyl-trimethylammonium 6. Dodecyl-trimethylammonium 7. Tetradecyl-trimethylammonium 8. Hexadecyl-trimethylammonium

Time (min)	%A	%B	%C
-12	5	5	90
0	5	5	90
12	40	5	55
20	40	5	55

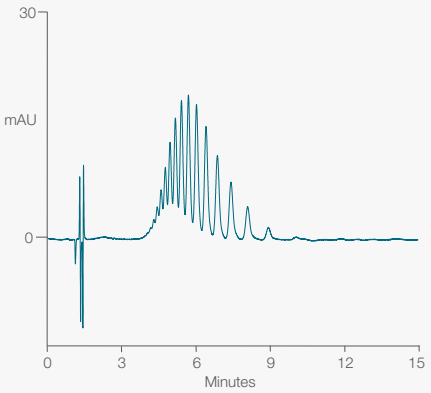
Figure 3. Separation of alkyl quaternary amines using conductivity detection

Excellent resolution for ethoxylated surfactants

The novel column chemistry of Acclaim Surfactant Plus column offers excellent resolution for individual oligomers of ethoxylated surfactants.

Nonionic ethoxylated surfactants account for about 40% of the surfactants consumption worldwide. Most nonionic surfactants are considered low-foaming products, have good cold water solubility, and low critical micelle concentration. Their compatibility with cationic fabric softeners makes them preferable in certain formulations. Figures 4 and 5 demonstrate that the Acclaim Surfactant Plus column provides excellent resolution between individual oligomers in two nonionic ethoxylated surfactants.

Ethoxylated lauryl sulfates, also called laureth sulfates, are prepared by adding oxyethylene groups to an alcohol that is then sulfated. Ethoxylation enhances water solubility and foaming, making these surfactants ideal components in shampoos and detergents. Figure 6 shows the profiles of laureth sulfates obtained on an Acclaim Surfactant Plus column using a charged aerosol detector.



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Mobile phases	40/60v/v CH_3CN/10 mM (total) NH_4OAc, pH 5
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	UV, 225 nm
Sample	Triton X-100 (1 mg/mL)

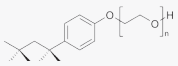
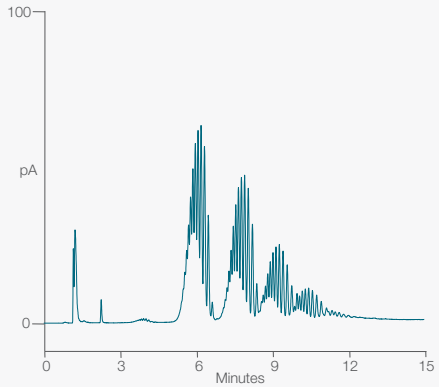


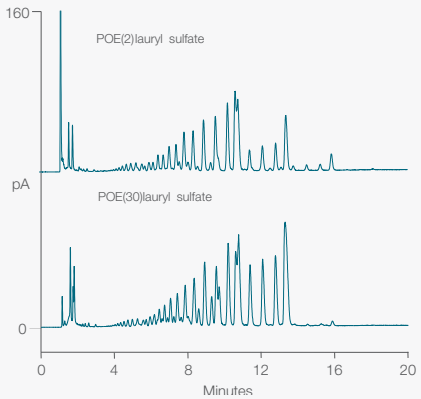
Figure 4. Triton X-100



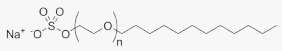
Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS Charged Aerosol Detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Zonyl FSO fluorosurfactant (10 mg/mL) $(C_2H_4)x(CF_2)_yC_2H_5OH$

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	30	70
0	30	70
10	60	40
15	60	40

Figure 5. Zonyl FSO fluorosurfactant



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS Charged Aerosol Detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	10 mg/mL each



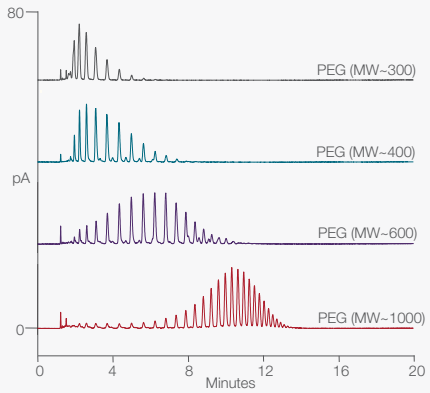
Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-10	45	55
0	45	55
15	75	25
20	75	25

Figure 6. Profile of ethoxylated lauryl sulfates

Polyethylene glycols (PEGs) are often non surfactant impurities found in ethoxylated surfactants, typically in the range of 1–10%. The oligomer distribution is similar to, but broader than that of the surfactant. Figure 7 illustrates the exceptional resolution of the Acclaim Surfactant Plus column for individual oligomers in various PEGs.

Compatible withhighly aqueous mobile phase conditions

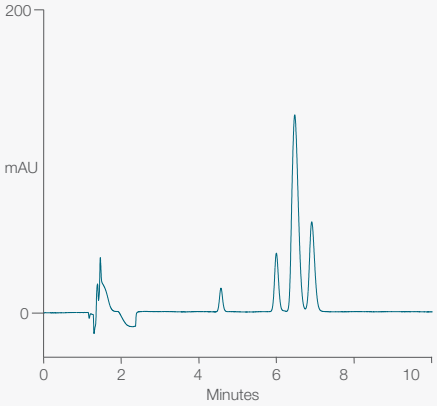
High-density C18 columns often fail to retain highly hydrophilic hydrotropes, such as sodium naphthalene sulfonate and xylene sulfonate. The problem arises because these analyses require a highly aqueous mobile phase that will lead to undesirable “dewetting” – sudden drop of retention and deformed peak shape. As illustrated in Figure 8, the Acclaim Surfactant Plus column provides adequate retention of xylene sulfonate, while under the same condition it would elute close to the void on a conventional C18 column.



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	POE(30) laurylsulfate (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Samples	(2.5 mg/mL each)
	PEG (MW~300)
	PEG (MW~400)
	PEG (MW~600)
	PEG (MW~1000)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	2	98
0	2	98
20	20	80

Figure 7. Polyethylene glycols (PEGs)



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Mobile phases	30/70v/v CH_3CN/20 mM (total) NH_4OAc, pH 5
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	UV, 225 nm
Sample	Sodium xylene sulfonate (1 mg/mL)

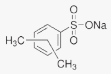


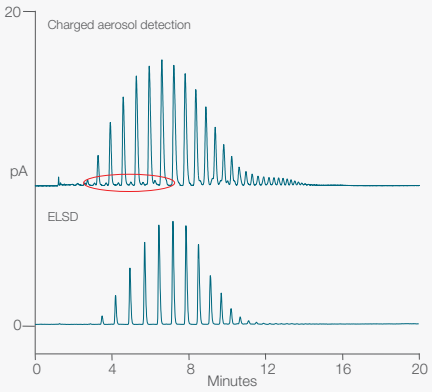
Figure 8. Determination of xylene sulfonates

Compatible with various detection methods

The Acclaim Surfactant Plus column provides optimum selectivity for various types of surfactants using volatile mobile phases (e.g., ammonium acetate). Detection methods include charged aerosol detection, ELSD, UV, SCD, and MS. Other HPLC mobile phases, such as phosphate buffers, can also be used when the surfactants of interest have chromophore and UV detection is employed.

The Corona *ultra* RS charged aerosol detector uses a unique and innovative detection method to detect nonvolatile analytes like surfactants, and offers performance benefits unequaled by refractive index (RI), UV and ELSD. Its benefits include high sensitivity (sub to single digit nanogram), excellent injection-to-injection reproducibility, wide dynamic range, and gradient compatibility. Therefore, the Corona *ultra* RS charged aerosol detector is the preferred detector to accompany Acclaim Surfactant Plus columns for determinations of various types of surfactants.

Figure 9 demonstrates the superior sensitivity of the Corona *ultra* RS charged aerosol detector compared to an ELS detector. In addition, methods developed with charged aerosol detection can be easily transferred to liquid chromatography-electrospray ionization-mass spectrometry (LC-ESI-MS) methods with little or no modifications, because both detectors share the same mobile phase requirements. Figure 10 illustrates simultaneous separation and identification of a mixture of cationic, nonionic, amphoteric, and anionic surfactants on an Acclaim Surfactant Plus column by LC-ESI-MS.

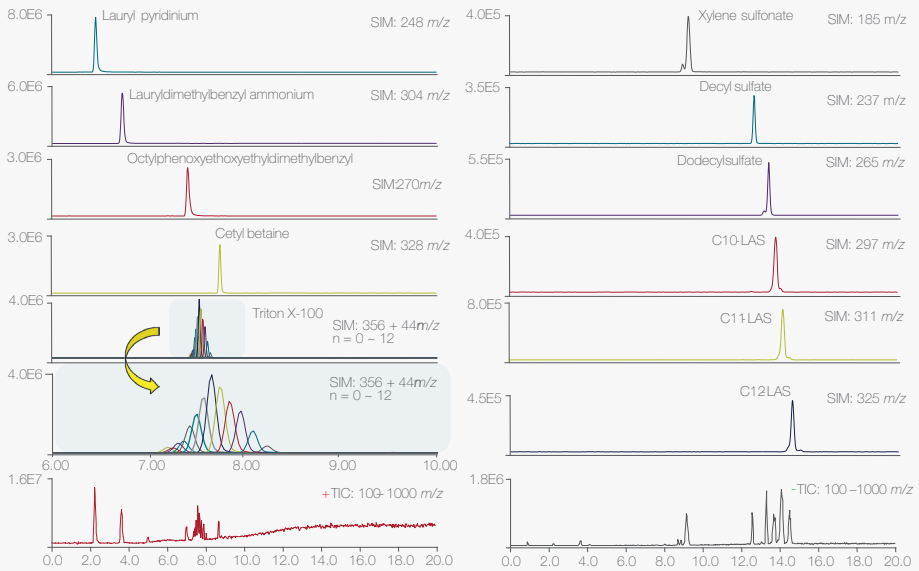


Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp = 20 °C) Sedex-85 ELSD (Gain = 10 pA; Evap. temp. = 50 °C)
Sample	PEG monoethyl ether (MW ~ 550), 5 mg/mL

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	2	98
0	2	98
20	20	80

Figure 9. Sensitivity comparison of charged aerosol detection vs. ELSD

SCD provides excellent sensitivity and selectivity for ionic analytes, making it suitable for detecting ionic surfactants in a wide range of sample matrices with greatly reduced interferences from other components in the sample. Figures 3 and 17 demonstrate selective and sensitive detection of cationic surfactants on an Acclaim Surfactant Plus column using SCD.



Chromatography conditions	
System	Thermo Scientific™ UltiMate™ 3000 RSLC
Column	Acclaim Surfactant Plus, 3 µm
Dimensions	2.1 × 150 mm
Mobile phase	A: D.I. water; B: 100 mM ammonium acetate, pH 5; C: Acetonitrile
Temperature	30 °C
Flow rate	0.3 mL/min
MS conditions	
System	Thermo Scientific™ MSQ™ Plus single quadrupole mass spectrometor
Interface	Electrospray ionization (ESI)
Probe temp.	450 °C
Needle vol.	3 kV
Nebulizer gas	Nitrogen at 85 psi
Scan mode	Polarity switching full scan 100 - 1000 *m/z*

Time (min)	%A	%B	%C
-10	65	5	30
0	65	5	30
1	65	5	30
8	10	5	85
20	10	5	85

Figure 10. Simultaneous analysis of cationic, nonionic, amphoteric and anionic surfactants by LC-ESI-MS

Broad range of applications

The Acclaim Surfactant Plus column can be used for analyzing a variety of consumer and personal care products, such as laundry detergent, fabric softener, shampoo, dish washing liquid, nasal spray, eye drops, mouthwash, etc.

Laundry detergents

Laundry detergents contain many components, including biodegradable surfactants. While dodecyl benzene sulfonate (LAS), a petroleum derived biodegradable anionic surfactant, has been widely used in laundry detergents, the modern formulation prefer to use plant-derived surfactants for their environmental and consumer safety benefits. Figure 11 shows the profiles of two laundry detergents – one is 100% plant-derived and the other contains LAS.

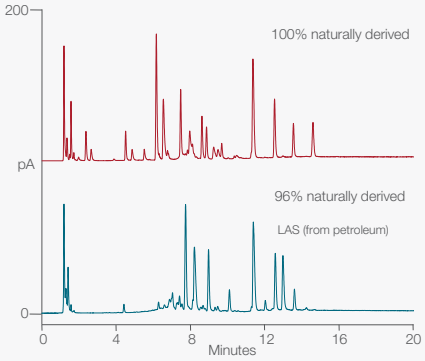


Figure 11. Laundry detergents

Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Samples	Laundry detergents (20x dilution with D.I. water and filtered) Brand A: 100% naturally derived Brand B: 96% naturally derived

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
20	80	20

Fabric softener

Cationic surfactants are often used in fabric softeners to neutralize the detergents, eliminate static electricity and soften clothes. The Acclaim Surfactant Plus column, as shown in Figure 12, provides excellent resolution and symmetrical peaks when used to analyze a fabric softener.

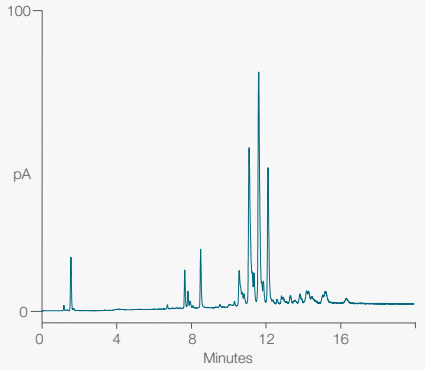


Figure 12. Fabric softener

Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Fabric softener (40x dilution)
Sample prep	1. Dissolve 0.5 g of sample in 20 mL of 75% ethanol 2. Sonicate the mixture for 5 min 3. Filter the suspention through the 0.2 µm membrane filter

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	30	70
0	30	70
10	85	15
20	85	15

Shampoo

Shampoos contain various combinations of anionic, cation, nonionic, and amphoteric surfactants, designed to influence the essential characteristics of the shampoo: cleansing, foam, conditioning, and viscosity. Laureth sulfates are commonly used in shampoos to provide lather and cleansing. As shown in Figure 13, the individual oligomers in laureth sulsate are well resolved using the Acclaim Surfactant Plus column.

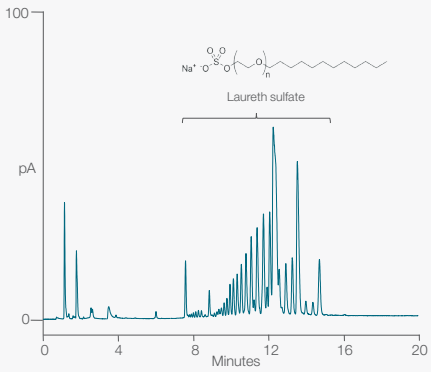


Figure 13. Shampoo

Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	2 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Shampoo (40x dilution with D.I. water and filtered)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
20	80	20

Liquid hand soap

While various surfactants are used in liquid hand soaps, the hydrotrope xylene sulfonate is the main component in a high foaming liquid hand soap, determined with a Acclaim Surfactant Plus column (Figure 14).

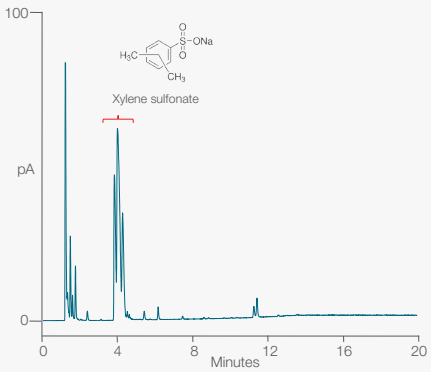


Figure 14. Liquid hand soap

Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	1 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Liquid hand soap (40x dilution with D.I. water and filtered)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
20	80	20

Nasal spray and eye drops

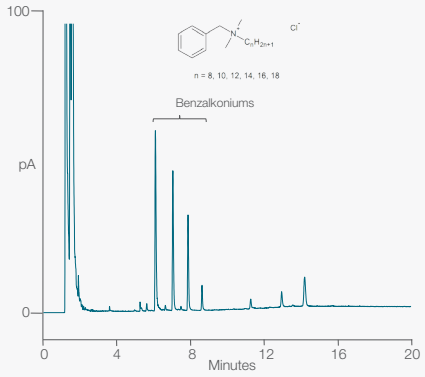
Benzalkonium salts are widely used preservative in nasal sprays and ophthalmic formulations because of their antimicrobial effects. Figure 15 and 16 show the chromatographic separation of the major homologs of benzalkonium salts in nasal spray and eye drops, respectively, with excellent separation and symmetrical peaks.

Mouthwash

Alkyl pyridinium salts are mild antibacterial agents used in various pharmaceutical products such as mouthwash, cough drops, and so forth. As shown in Figure 17, the Acclaim Surfactant Plus column, combined with cation suppressor and conductivity detector, can selectively and sensitively determine cetyl pyridinium in a mouthwash product.

Reproducible manufacturing

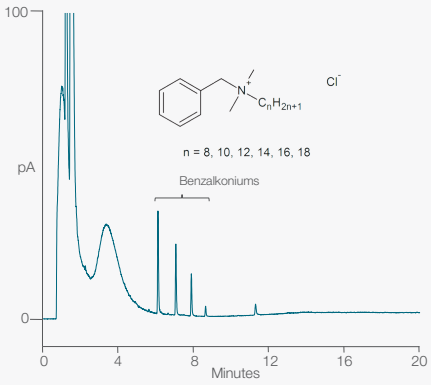
To meet the exact needs of our customers, each Acclaim Surfactant Plus column is manufactured to stringent specifications to ensure column-to-column reproducibility. Each column is shipped with a lot validation sheet showing the test results and specifications for the lot of bonded silica packed into the column. In addition, each column is individually tested and shipped with an individual test chromatogram validating the column performance, with respect to selectivity, retention, and efficiency.



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	5 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Nasal spray (filter and injection)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
20	80	20

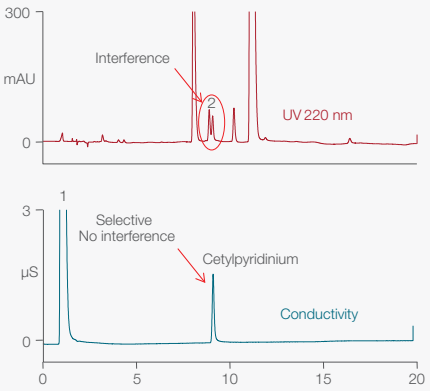
Figure 15. Nasal spray



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
Temperature	30 °C
Flow rate	0.6 mL/min
Inj. volume	5 µL
Detection	Corona *ultra* RS charged aerosol detector (Gain = 100 pA; Filter = med; Neb temp. = 20 °C)
Sample	Nasal spray (filter and injection)

Time (min)	Acetonitrile	0.1 M Ammonium Acetate, pH 5
-8	25	75
0	25	75
10	80	20
20	80	20

Figure 16. Eye drops



Column	Acclaim Surfactant Plus, 3 µm
Dimensions	3.0 × 150 mm
System	Thermo Scientific™ ICS™ 3000
Mobile phase	A: Acetonitrile; B: 100 mM Formic acid; C: Water
Temperature	25 °C
Flow rate	0.5 mL/min
Inj. volume	5 µL
Detection	UV, 220 nm (with blank subtraction) Conductivity (with blank subtraction)
Suppressor	CSRS300 -2 mm (external water 1.0 mL/min, current = 8 mA)
Sample	Mouthwash (filter and injection)

Time (min)	%A	%B	%C
-12	15	5	80
0	15	5	80
12	40	5	55
20	40	5	55

Figure 17. Selective detection of the cationic surfactant in mouthwash with SCD

thermo scientific

Column specifications

Specifications	
pH range	2.5 – 7.5 (3.0 – 6.0 recommended)
Temperature limit	Up to 50 °C
Operating pressure (max)	Up to 6000 psi, except for 3 µm, 2.1 × 250 mm P/N 078953 (Up to 10,000 psi) and 5 µm, 4 × 150 mm (PEEK) P/N 078956 (Up to 4,000 psi)
Operating flow rate (max)	0.60 – 1.80 mL/min for 4.6 mm i.d. column 0.30 – 0.90 mL/min for 3.0 mm i.d. column 0.15 – 0.45 mL/min for 2.1 mm i.d. column
Storage solution	Acetonitrile/20 mM NH_4OAc, pH 5 v/v 90/10 or 100% Acetonitrile
Aqueous compatibility	0 – 100% aqueous mobile phase
Organic compatibility	Fully compatible with common HPLC solvents THF and Acetone are incompatible with PEEK column body thus should be avoided when using P/N 078956

Ordering information

Column	Particle size (µm)	Format	Length (mm)	ID (mm)	Part number
Acclaim Surfactant Plus	3.0	Analytical	150	4.6	078950
			150	3.0	078951
			100	3.0	078952
			250	2.1	078953
			150	2.1	078954
			100	2.1	078955
	5.0	Analytical	150	4.6	082768
			250	4.6	082767
			150	4.0	078956
		Guard	10	4.6	082773
			10	3.0	078959
			10	2.1	078960

Acclaim Guard Holder ordering information

Guard holder	Part number
Thermo Scientific™ Acclaim™ Guard Cartridge Holder V-2	069580
Thermo Scientific™ Acclaim™ Guard Kit (Holder and coupler) V-2	069707
Guard to Analytical Column Coupler V-2	074188

Expect reproducible results with sample prep, columns and vials

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