# Detergents Properties and Applications

Detergents are water-soluble, surface-active agents composed of a hydrophilic head group and a hydrophobic or lipophilic tail group. Due to their amphiphilic character, detergent molecules aggregate in solution to form micelles. They can also align at aqueous/non-aqueous interfaces, reducing surface tension, increasing miscibility, and stabilizing emulsions.

## NONIONIC

| | BigCHAP | Deoxy BigCHAP | Brij® 35 | Brij 58 P | Cymal-1 | Cymal-2 | Cymal-5 | Cymal-6 | Decyl-β-D-maltopyranoside | n-Dodecyl-β-D-maltoside | n-Hexadecyl-β-D-maltoside | Undecyl-β-D-maltoside | Decyl-β-D-1-thiomaltopyranoside | Octyl-β-D-glucopyranoside | Decyl-β-D-1-thioglucopyranoside |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product Code(s) | B 9518 | 14840 | P 1254 | P 5884 | 29467 | 29395 | 96193 | 29396 | D 7658 | D 4641 | H 6262 | 94206 | 30727 | O 8001 | 30726 |
| | | | 16012 | | | | | | | | | | | O 3757 | |
| CAS Number | 86303-22-2 | 86303-23-3 | 9002-92-0 | 9004-95-9 | 260804-64-6 | 260804-65-7 | 319439-34-4 | 228579-27-9 | 82494-09-5 | 69227-93-6 | 98064-96-1 | 170552-39-3 | 148565-56-4 | 29836-26-8 | 98854-16-1 |
| MW (anhydrous) | 878 | 862 | 1200 | 1122 | 439 | 453 | 495 | 509 | 483 | 511 | 567 | 497 | 499 | 292 | 336 |
| CMC** (mM) | 3.4 | 1.1-1.4 | 0.05-0.1 | 0.08 | 340 | 120 | 2.4-5 | 0.56 | 1.6 | 0.15 | 0.0006 | 0.59 | 0.9 | 20-25 | 0.9 |
| Aggregation Number | 10 | 8-16 | 20-40 | 70 | * | * | 66 | 63 | * | 98 | * | * | * | 84 | * |
| HLB | * | * | 16.9 | 15.7 | * | * | * | * | * | * | * | * | * | * | * |
| Cloud Point (°C) | * | * | >100 | >100 | * | * | * | * | * | * | * | * | * | >100 | * |
| Average Micellar Weight | 8,800 | 10,500 | 48,000 | 79,000 | * | * | 32,600 | 32,000 | * | 50,000 | * | * | * | 25,000 | * |
| **APPLICATIONS** | | | | | | | | | | | | | | | |
| Diagnostic Applications | | | • | | | | | | | • | | | | • | |
| Molecular Biology | | | | | | | | | | | | | | | |
| Cell Culture | | | | | | | | | | | | | | | |
| Electrophoresis/ Chromatography | • | • | • | • | | | | | | • | | | | • | |
| Membrane Protein Solubilization | | | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Enzymology | | | • | • | | | | | | • | | | | • | |
| Antigen/ Vaccine Preparation | | | | | | | | | | • | | | | • | |
| Drug Delivery/Liposomes | | | • | | | | | | | • | | | | • | |

## NONIONIC

| | Octyl-β-D-thioglucopyranoside | Digitonin | Dimethyldecylphosphine oxide (APO-10) | Dodecyldimethylphosphine oxide (APO-12) | IGEPAL® CA-630 | N-Octanoyl-N-methylglucamine (MEGA-8) | N-Nonanoyl-N-methylglucamine (MEGA-9) | N-Decanoyl-N-methylglucamine (MEGA-10) | Nonidet® P40-substitute | Pluronic F-68 | Saponin | Thesit® | Triton® X-100 | Triton X-114 | TWEEN® 20 | TWEEN 40 | TWEEN 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product Code(s) | O 6004 | D-141 | 40108 | 40223 | I 7771 | O 3129 | N 1138 | D 6277 | 74385 | P 1300 | S 4521 | 17228 | T 8532 | X-114 | P 8942 | P 1504 | P 8192 |
| | | | | | I 3021 | | | | 74388 | | | | 93427 | | P 8341 | | P 6474 |
| | | | | | I 8896 | | | | | | | | | | P 7949 | | P 8074 |
| CAS Number | 85618-21-9 | 11024-24-1 | 2190-95-6 | 871-95-4 | 9036-19-5 | 85316-98-9 | 85261-19-4 | 85261-20-7 | 9016-45-9 | 9003-11-6 | 8047-15-2 | 9002-92-0 | 9002-93-1 | 9036-19-5 | 9005-64-5 | 9005-66-7 | 9005-65-6 |
| MW (anhydrous) | 308 | 1229 | 218 | 246 | * | 321 | 336 | 350 | 680 | 8350 | * | 583 | 625 | 537 | 1228 | * | 1310 |
| CMC** (mM) | * | 60 | 131 | 2232 | * | * | * | * | * | * | * | * | 100-155 | * | * | * | 60 |
| Aggregation Number | * | * | * | * | 13 | * | * | * | * | 29 | * | * | 13.5 | 12.4 | 16.7 | * | 15 |
| HLB | * | * | * | * | * | * | * | * | 45-50 | * | * | * | 65 | 23 | 76 | * | 65 |
| Cloud Point (°C) | * | 70,000 | 28,597 | 549,965 | * | * | * | * | * | * | * | * | 80,000 | * | * | * | 79,000 |
| Average Micellar Weight | * | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| **APPLICATIONS** | | | | | | | | | | | | | | | | | |
| Diagnostic Applications | | • | | | | | | | | | | | | | | | |
| Molecular Biology | | | • | | • | | | | • | | | | • | | | | |
| Cell Culture | | • | | | • | | | | • | • | | | | | • | • | • |
| Electrophoresis/ Chromatography | | | | | • | | | | • | | | | • | | • | • | |
| Membrane Protein Solubilization | • | • | • | • | • | • | • | • | • | • | | • | • | • | • | • | • |
| Enzymology | • | • | | | • | • | • | • | • | | | • | • | • | • | • | • |
| Antigen/ Vaccine Preparation | | | | | • | | | • | • | | • | | | | | | |
| Drug Delivery/Liposomes | | | | | • | • | • | • | • | • | • | • | | | • | • | • |

## ANIONIC

| | Sodium cholate | Sodium deoxycholate | Sodium glycocholate | Sodium taurocholate | Sodium taurodeoxycholate | N-Lauroylsarcosine | Lithium dodecyl sulfate | Sodium dodecyl sulfate (SDS) |
|---|---|---|---|---|---|---|---|---|
| Product Code(s) | C 1254 | D 6750 | G 7132 | T 4009 | T 0875 | L 7414 | L 4632 | L 3771 |
| | | | | | | L 9150 | | |
| CAS Number | 73163-53-8 | 302-95-4 | 863-57-0 | 145-42-6 | 1180-95-6 | 137-16-6 | 2044-56-6 | 151-21-3 |
| MW (anhydrous) | 431 | 415 | 488 | 538 | 522 | 293 | 272 | 289 |
| CMC** (mM) | 9-15 | 2-6 | 7 | 3-11 | 1-4 | 14.6 | 7-10 | 7-10 |
| Aggregation Number | 2-3 | 3-12 | 2 | 4 | 6 | 2 | * | 62 |
| HLB | 18 | 16 | * | * | * | * | * | 40 |
| Cloud Point (°C) | * | * | * | * | * | * | * | >100 |
| Average Micellar Weight | 900-1300 | 1200-5000 | 1000 | 2100 | 3100 | 600 | * | 18,000 |
| **APPLICATIONS** | | | | | | | | |
| Diagnostic Applications | • | • | | | • | | • | • |
| Molecular Biology | • | • | | | | • | | • |
| Cell Culture | | | | | | | | |
| Electrophoresis/ Chromatography | • | • | | | | | • | • |
| Membrane Protein Solubilization | • | • | | • | • | • | • | • |
| Enzymology | • | | | | | | | • |
| Antigen/ Vaccine Preparation | • | • | • | | | | • | • |
| Drug Delivery/ Liposomes | • | • | | | | | | • |

## CATIONIC

| | Hexadecyltrimethyl ammonium bromide (CTAB) | Trimethyl(tetradecyl) ammonium bromide (TTAB) |
|---|---|---|
| Product Code(s) | H 6269 | T 4762 |
| | H 5882 | |
| CAS Number | 57-09-0 | 1119-97-7 |
| MW (anhydrous) | 365 | 337 |
| CMC** (mM) | 1 | 4-5 |
| Aggregation Number | 170 | 80 |
| HLB | * | * |
| Cloud Point (°C) | * | * |
| Average Micellar Weight | 62,000 | 27,000 |
| **APPLICATIONS** | | |
| Diagnostic Applications | • | • |
| Molecular Biology | | |
| Cell Culture | | |
| Electrophoresis/ Chromatography | | |
| Membrane Protein Solubilization | | |
| Enzymology | | |
| Antigen/ Vaccine Preparation | | |
| Drug Delivery/ Liposomes | | |

## ZWITTERIONIC

| | ASB-14 (amidosulfobetaine-14) | ASB-16 (amidosulfobetaine-16) | C7BzO | CHAPS | CHAPSO | EMPIGEN® BB | 3-(N,N-Dimethyloctylammonio) propanesulfonate inner salt (SB3-8) | 3-(Decyldimethylammonio) propanesulfonate inner salt (SB3-10) | 3-(Dodecyldimethylammonio) propanesulfonate inner salt (SB3-12) | 3-(N,N-Dimethylmyristylammonio) propanesulfonate (SB3-14) | 3-(N,N-Dimethylpalmitylammonio) propanesulfonate (SB3-16) | 3-(N,N-Dimethyloctadecylammonio) propanesulfonate (SB3-18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product Code(s) | A 1346 | 94508 | C 0856 | C 9426 | C 9551 | 45165 | O 6626 | D 4266 | D 4516 | T 7763 | H 6883 | O 8004 |
| CAS Number | 216667-08-2 | 52562-29-5 | * | 75621-03-3 | 82473-24-3 | 66455-29-6 | 15178-76-4 | 15163-36-7 | 14933-08-5 | 14933-09-6 | 2281-11-0 | 13177-41-8 |
| MW (anhydrous) | 435 | 463 | 400 | 615 | 631 | 272 | 280 | 308 | 336 | 364 | 392 | 420 |
| CMC** (mM) | * | * | * | 6 | 8 | 1.6-2.1 | 330 | 25-40 | 2-4 | 0.1-0.4 | 0.01-0.06 | * |
| Aggregation Number | * | * | * | 10 | 11 | * | * | 41 | 55 | 83 | 155 | * |
| HLB | * | * | * | * | * | * | * | * | * | * | * | * |
| Cloud Point (°C) | * | * | * | >100 | 90 | * | * | * | * | * | * | * |
| Average Micellar Weight | * | * | * | 6150 | 7000 | * | * | 12,600 | 18,500 | 30,200 | 60,700 | * |
| **APPLICATIONS** | | | | | | | | | | | | |
| Diagnostic Applications | | | | • | | | | | • | • | | |
| Molecular Biology | | | | | | | | | | | | |
| Cell Culture | | | | | | | | | | | | |
| Electrophoresis/ Chromatography | | | | • | • | | | | • | • | | |
| Membrane Protein Solubilization | • | • | • | • | • | • | • | • | • | • | • | • |
| Enzymology | | | | • | • | • | | | • | • | | |
| Antigen/ Vaccine Preparation | | | | • | | • | | | • | | | |
| Drug Delivery/ Liposomes | | | | • | | | | | | | | |

## NON-DETERGENT SULFOBETAINES

| | 3-(1-Pyridinio)-1-propanesulfonate (NDSB 201) | 3-(Benzyldimethylammonio) propanesulfonate (NDSB 256) |
|---|---|---|
| Product Code(s) | 82804 | 17236 |
| CAS Number | 15471-17-7 | 081239-45-4 |
| MW (anhydrous) | 201 | 257 |
| CMC** (mM) | These products do not form micelles | |
| Aggregation Number | | |
| HLB | | |
| Cloud Point (°C) | | |
| Average Micellar Weight | | |
| **APPLICATIONS** | | |
| Diagnostic Applications | | |
| Molecular Biology | | |
| Cell Culture | | |
| Electrophoresis/ Chromatography | | |
| Membrane Protein Solubilization | • | • |
| Enzymology | | |
| Antigen/ Vaccine Preparation | | |
| Drug Delivery/ Liposomes | | |

*data not available
**CMC in water at 20-25 °C

**Detergent Categories**
In order to help choose a detergent for a particular application, detergents have been grouped into four categories, based on the nature of the hydrophilic head group:

**Nonionic** Gentle detergents used for solubilizing proteins while maintaining native subunit structure, enzymatic activity, or other functions.

**Anionic** Strong detergents that often completely disrupt cell membranes and fully denature proteins. They are sensitive to pH, ionic strength and the nature of the counterion and can interfere with charge-based analytical methods.

**Cationic** Strong detergents with properties similar to those above for anionic detergents. These are used in DNA purification, as surfactants in drug/vaccine delivery systems and in cleaning and disinfecting applications.

**Zwitterionic** Electrically neutral detergents that not only protect the native state of proteins but also prevent non-specific aggregation. They are often useful alternatives to nonionic detergents in ion-exchange, electrophoresis, and isoelectric focusing.

**Non-detergent Sulfobetaines** Although not detergents, these reagents possess hydrophilic groups similar to those of zwitterionic detergents but with much shorter hydrophobic chains. They may improve the yield of membrane proteins when used with detergents and reportedly prevent aggregation of denatured proteins.

**Physical Properties**

**CMC** is the critical micellular concentration, the concentration at which micelles begin to form (i.e. the maximum monomer concentration). It should be noted that micelles cannot form, even above this concentration if the temperature is too low. The minimum temperature for self-aggregation is called the critical micellar temperature (CMT). The lower the CMC, the more stable the micelle and the more slowly molecules are incorporated into or removed from the micelle. CMC values are a guide to detergent hydrophobic binding strengths. The higher the CMC, the weaker the binding and the easier the removal of the detergent, such as by dialysis.

**Aggregation Number** is the average number of monomers in a micelle. A low aggregation number and high CMC favor removal by dialysis.

**HLB** is the hydrophile-lipophile balance. It defines the hydrophilic character of the detergent. A low HLB favors removal of the detergent by reverse-phase chromatography.

Cloud point temperature is the temperature at which a detergent solution begins to look cloudy due to aggregation into larger structures that scatter light. The cloud point phenomenon interferes with applications that require optical clarity, but can be used to advantage in removing a detergent from aqueous solution.

**Cloud Point** temperature is the temperature at which a detergent solution begins to look cloudy due to aggregation into larger structures that scatter light. The cloud point phenomenon interferes with applications that require optical clarity, but can be used to advantage in removing a detergent from aqueous solution.