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	*
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)	*	<0.5	4.6	0.568	0.08	58	19-25	6-7	.059	0.04	*	0.1	0.2-0.9	0.2	0.06	0.027	0.012
Aggregation Number	*	60	131	2232	*	*	*	*	*	*	*	*	100-155	*	*	*	60
HLB	*	*	*	*	13	*	*	*	*	29	*	*	13.5	12.4	16.7	*	15
Cloud Point (°C)	*	*	*	*	*	*	*	*	45-50	*	*	*	65	23	76	*	65
Average Micellar Weight	*	70,000	28,597	549,965	*	*	*	*	*	*	*	*	80,000	*	*	*	79,000
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
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
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	*
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		
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.

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