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# Lutensol® TO types

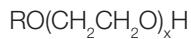
Lutensol TO 2	Lutensol TO 89
Lutensol TO 3	Lutensol TO 10
Lutensol TO 5	Lutensol TO 109
Lutensol TO 6	Lutensol TO 11
Lutensol TO 65	Lutensol TO 12
Lutensol TO 7	Lutensol TO 129
Lutensol TO 79	Lutensol TO 15
Lutensol TO 8	Lutensol TO 20
	Lutensol TO 389

Nonionic surfactants for use in detergents and cleaners and  
for the chemical and allied industries

**Chemical nature**

The Lutensol TO types are nonionic surfactants. They are based on a saturated iso-C<sub>13</sub> alcohol.

They conform to the following structural formula.



where



$x = 2, 3, 5, 6, 6, 5, 7, 8, 10, 11, 12, 15, 20$

The numeric code in the product name indicates the degree of ethoxylation.

Lutensol TO 79 consists of approx. 90% Lutensol TO 7 and approx. 10% water.  
Lutensol TO 89 consists of approx. 90% Lutensol TO 8 and approx. 10% water.

Lutensol TO 109 consists of approx. 85% Lutensol TO 10 and approx. 15% water.  
Lutensol TO 129 consists of approx. 85% Lutensol TO 12 and approx. 15% water.

Lutensol TO 389 is a special mixture of Lutensol TO 3 and Lutensol TO 8 with an active content of approx. 90% and a water content of approx. 10%.

The Lutensol TO types are manufactured by causing the iso-C<sub>13</sub> oxo alcohol to react with ethylene oxide in stoichiometric proportions. The ethoxylation temperature is kept as low as possible. This, combined with the high purity of the feedstocks, ensures that high-performance products with low toxicity are obtained.

**PRD-Nos.\***

30178622	Lutensol TO 2
30044003	Lutensol TO 3
30044057	Lutensol TO 5
30044177	Lutensol TO 6
30090427	Lutensol TO 65
30044060	Lutensol TO 7
30091779	Lutensol TO 79
30044015	Lutensol TO 8
30044017	Lutensol TO 89
30044009	Lutensol TO 10
30044022	Lutensol TO 109
30151997	Lutensol TO 11
30044036	Lutensol TO 12
30044020	Lutensol TO 129
30044000	Lutensol TO 15
30044001	Lutensol TO 20
30044067	Lutensol TO 389

\*BASF's commercial product numbers.

**Properties**

Lutensol TO 2, TO 3, TO 5, TO 6, TO 65, TO 7 and TO 8 are cloudy liquids at 23 °C which tend to form a sediment. They are clear at 50 °C.

Lutensol TO 79, TO 89, TO 109, TO 129 and TO 389 are clear liquids at 23 °C.

Lutensol TO 10, TO 11, TO 12, TO 15 and TO 20 are soft, slightly yellowish pastes.

Lutensol	TO 2	TO 3	TO 5	TO 6	TO 65	TO 7
Physical form (23 °C)	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid
Degree of ethoxylation	approx. 2	approx. 3	approx. 5	approx. 6	approx. 6.5	approx. 7
Concentration	%	approx. 100				
Cloud point (EN 1890)*						
Method A	°C	—	—	—	—	—
Method B	°C	—	—	—	—	—
Method C	°C	—	—	—	—	—
Method D	°C	approx. 37	approx. 50	approx. 66	approx. 70	approx. 71
Method E	°C	—	approx. 40	approx. 62	approx. 67	approx. 68
Molar mass (calculated from hydroxyl number)	g/mol	approx. 295	approx. 340	approx. 430	approx. 470	approx. 485
pH (5% in water)**		approx. 7				
Density (DIN 51757, 23 °C)	g/cm <sup>3</sup>	approx. 0.90	approx. 0.93	approx. 0.96	approx. 0.97	approx. 0.98
Dropping point (DIN 51801)	°C	<5	<5	approx. 14	approx. 18	approx. 18
Congealing point (ISO 2207)	°C	<5	<5	<5	<5	approx. 5
Melting point	°C					
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	approx. 30	approx. 50	approx. 80	approx. 80	approx. 100
Hydroxyl number (DIN 53240)	mgKOH/g	approx. 190	approx. 165	approx. 130	approx. 120	approx. 115
Hydrophilic-lipophilic balance		approx. 7	approx. 9	approx. 10.5	approx. 11	approx. 11.5
Flash point (DIN 51376)	°C	>100	>100	>100	>100	>100
Wetting power (EN 1772, in distilled water with 2 g/l soda ash at 23 °C)						
0.5 g/l	s	>300	>300	approx. 80	approx. 60	approx. 60
1.0 g/l	s	>300	>300	approx. 50	approx. 25	approx. 20
2.0 g/l	s	approx. 150	approx. 230	approx. 20	approx. 10	approx. 10
Foam formation (EN 12728, 40 °C, 2 g/l in water with 1.8 mmol Ca <sup>2+</sup> -Ions/l, after 30 sec)	cm <sup>3</sup>	approx. 10	approx. 10	approx. 50	approx. 70	approx. 90
Surface tension*** (EN 14370, 1 g/l in distilled water at 23 °C)	mN/m	approx. 27				

\* Cloud point according to EN 1890:

Method A : 1 g of surfactant + 100 g of distilled water

Method B : 1 g of surfactant + 100 g of NaCl solution (c = 50 g/l)

Method C : 1 g of surfactant + 100 g of NaCl solution (c = 100 g/l)

Method D : 5 g of surfactant + 45 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

Method E : 5 g of surfactant + 25 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

\*\* The pH of the Lutensol TO types can decrease during storage, but this does not have any effect on their performance.

\*\*\* Applying Harkins-Jordan correction.

Lutensol	TO 79	TO 8	TO 89	TO 10	TO 109	TO 11
Physical form (23 °C)	Liquid	Liquid	Liquid	Liquid	Liquid	Paste
Degree of ethoxylation	approx. 7	approx. 8	approx. 8	approx. 10	approx. 10	approx. 11
Concentration	%	approx. 90	approx. 100	approx. 90	approx. 100	approx. 85
Cloud point (EN 1890)*						
Method A	°C	–	approx. 60	approx. 60	approx. 70	approx. 70
Method B	°C	–	approx. 46	approx. 46	approx. 54	approx. 54
Method C	°C	–	approx. 35	approx. 35	approx. 43	approx. 43
Method D	°C	approx. 72	approx. 80	approx. 80	approx. 81	approx. 81
Method E	°C	approx. 70	approx. 80	approx. 80	approx. 82	approx. 86
Molar mass (calculated from hydroxyl number)	g/mol	approx. 500	approx. 600	approx. 600	approx. 630	approx. 630
pH (5% in water)**		approx. 7	approx. 7	approx. 7	approx. 7	approx. 7
Density (DIN 51757, 23 °C)	g/cm <sup>3</sup>	approx. 0.99	approx. 1.01	approx. 1.02	approx. 0.97 (60 °C)	approx. 1.02 (60 °C)
Dropping point (DIN 51801)	°C	<5	approx. 22	<5	approx. 25	approx. 5
Congealing point (ISO 2207)	°C	<5	approx. 10	<5	approx. 14	<5
Melting point	°C				approx. 21	approx. 25
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	approx. 110	approx. 150	approx. 120	approx. 30 (60 °C)	approx. 150 (60 °C)
Hydroxyl number (DIN 53240)	mgKOH/g	approx. 110	approx. 95	approx. 95	approx. 90	approx. 90
Hydrophilic-lipophilic balance		approx. 12	approx. 13	approx. 13	approx. 13.5	approx. 13.5
Flash point (DIN 51376)	°C	>100	>100	>100	>100	>100
Wetting power (EN 1772, in distilled water with 2 g/l soda ash at 23 °C)						
0.5 g/l	s	approx. 60	approx. 70	approx. 90	approx. 80	approx. 80
1.0 g/l	s	approx. 20	approx. 25	approx. 30	approx. 30	approx. 35
2.0 g/l	s	approx. 5	approx. 10	approx. 10	approx. 10	approx. 20
Foam formation (EN 12728, 40 °C, 2 g/l in water with 1.8 mmol Ca <sup>2+</sup> -ions/l, after 30 sec)	cm <sup>3</sup>	approx. 50	approx. 550	approx. 550	approx. 600	approx. 600
Surface tension*** (EN 14370, 1 g/l in distilled water at 23 °C)	mN/m	approx. 27	approx. 28	approx. 28	approx. 28	approx. 29

\* Cloud point according to EN 1890:

Method A : 1 g of surfactant + 100 g of distilled water

Method B : 1 g of surfactant + 100 g of NaCl solution (c = 50 g/l)

Method C : 1 g of surfactant + 100 g of NaCl solution (c = 100 g/l)

Method D : 5 g of surfactant + 45 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

Method E : 5 g of surfactant + 25 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

\*\* The pH of the Lutensol TO types can decrease during storage, but this does not have any effect on their performance.

\*\*\* Applying Harkins-Jordan correction.

Lutensol	TO 12	TO 129	TO 15	TO 20	TO 389
Physical form (23 °C)	Paste	Liquid	Paste	Paste	Liquid
Degree of ethoxylation	approx. 12	approx. 12	approx. 15	approx. 20	approx. 7
Concentration	%	approx. 100	approx. 85	approx. 100	approx. 90
Cloud point (EN 1890)*					
Method A	°C	approx. 93	approx. 93	>100	>100
Method B	°C	approx. 75	approx. 75	approx. 80	approx. 86
Method C	°C	approx. 62	approx. 62	approx. 66	approx. 73
Method D	°C	approx. 87	approx. 87	approx. 88	approx. 90
Method E	°C	approx. 88	approx. 88	approx. 89	approx. 92
Molar mass (calculated from hydroxyl number)	g/mol	approx. 750	approx. 750	approx. 850	approx. 1000
pH (5% in water)**		approx. 7	approx. 7	approx. 7	approx. 7
Density (DIN 51757, 23 °C)	g/cm <sup>3</sup>	approx. 0.99 (60 °C)	approx. 1.04	approx. 1.00 (60 °C)	approx. 1.02 (60 °C)
Dropping point (DIN 51801)	°C	approx. 30	approx. 8	approx. 33	approx. 38
Congealing point (ISO 2207)	°C	approx. 20	<5	approx. 22	approx. 26
Melting point	°C	approx. 29		approx. 31	approx. 36
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	approx. 40 (60 °C)	approx. 200	approx. 50 (60 °C)	approx. 60 (60 °C)
Hydroxyl number (DIN 53240)	mgKOH/g	approx. 75	approx. 75	approx. 65	approx. 55
Hydrophilic-lipophilic balance		approx. 14.5	approx. 14.5	approx. 15.5	approx. 16.5
Flash point (DIN 51376)	°C	>100	>100	>100	>100
Wetting power (EN 1772, in distilled water with 2 g/l soda ash at 23 °C)					
0.5 g/l	s	approx. 120	approx. 120	approx. 160	>300
1.0 g/l	s	approx. 50	approx. 55	approx. 90	>300
2.0 g/l	s	approx. 20	approx. 20	approx. 40	approx. 200
Foam formation (EN 12728, 40 °C, 2 g/l in water with 1.8 mmol Ca <sup>2+</sup> -Ions/l, after 30 sec)	cm <sup>3</sup>	approx. 600	approx. 600	approx. 600	approx. 90
Surface tension*** (EN 14370, 1 g/l in distilled water at 23 °C)	mN/m	approx. 31	approx. 31	approx. 32	approx. 36

\* Cloud point according to EN 1890:

Method A : 1 g of surfactant + 100 g of distilled water

Method B : 1 g of surfactant + 100 g of NaCl solution (c = 50 g/l)

Method C : 1 g of surfactant + 100 g of NaCl solution (c = 100 g/l)

Method D : 5 g of surfactant + 45 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

Method E : 5 g of surfactant + 25 g of diethylene glycol monobutyl ether solution (c = 250 g/l)

\*\* The pH of the Lutensol TO types can decrease during storage, but this does not have any effect on their performance.

\*\*\* Applying Harkins-Jordan correction.

The above information is correct at the time of going to press. It does not necessarily form part of the product specification.

A detailed product specification is available from your local BASF representative.

**Solubility**

Details on the solubility of the Lutensol TO types in various solvents are given in the table below.

Solubility of the Lutensol TO types (10% solutions at 23 °C)

	Distilled water	Potable water (approx. 2.7 mmol Ca <sup>2+</sup> -ions/l)	Caustic soda (5%)	Hydro-chloric acid (5%)	Salt solution (5%)	Mineral oils	Alcohols	Aromatic hydro-carbons
Lutensol TO 2	—	—	—	—	—	+	+	+
Lutensol TO 3	—	—	—	—	—	+	+	+
Lutensol TO 5	—	—	—	—	—	+	+	+
Lutensol TO 6	—	—	—	—	—	+	+	+
Lutensol TO 65	—	—	—	—	—	+	+	+
Lutensol TO 7	—	—	—	—	—	+	+	+
Lutensol TO 79	—	—	—	—	—	+	+	+
Lutensol TO 8	+	+	—	+	+	(+)	+	—
Lutensol TO 89	+	+	+	+	+	+	+	—
Lutensol TO 10	+	+	+	+	+	—	+	—
Lutensol TO 109	+	+	+	+	+	(+)	+	—
Lutensol TO 11	+	+	+	+	+	—	+	—
Lutensol TO 12	+	+	+	+	+	—	+	—
Lutensol TO 129	+	+	+	+	+	(+)	+	—
Lutensol TO 15	+	+	+	+	+	—	+	—
Lutensol TO 20	+	+	+	+	+	—	+	—
Lutensol TO 389	—	—	—	—	—	(+)	+	+

— = Clear solution

(+) = Sparingly soluble

— = Insoluble

**Viscosity**

The relationship between viscosity and temperature is always an important point to consider as far as storage and shipping are concerned. This is shown in the following diagram (mPa · s, Brookfield LVT).

Viscosity at °C	0	10	20	23	30	40	50	60
Lutensol TO 2	250	120	60	30	20	10	<10	<10
Lutensol TO 3	350	150	70	50	35	25	15	10
Lutensol TO 5	>10 <sup>5</sup>	2600	110	80	50	30	20	10
Lutensol TO 6	>10 <sup>5</sup>	4500	180	80	60	30	20	15
Lutensol TO 65	16500	1700	600	100	70	30	25	20
Lutensol TO 7	>10 <sup>5</sup>	75000	500	100	60	40	30	20
Lutensol TO 79	550	250	130	110	75	50	30	20
Lutensol TO 8	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	300	75	50	40	25
Lutensol TO 89	1200	250	160	120	70	40	25	20
Lutensol TO 10	>10 <sup>5</sup>	>10 <sup>5</sup>	2000	1000	450	150	50	30
Lutensol TO 109	1200	600	220	150	100	70	35	25
Lutensol TO 11	>10 <sup>5</sup>	>10 <sup>5</sup>	3000	1500	700	200	70	30
Lutensol TO 12	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	20000	800	200	80	40
Lutensol TO 129	1200	650	280	200	150	80	50	35
Lutensol TO 15	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	30000	1500	250	100	50
Lutensol TO 20	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	2000	300	120	60
Lutensol TO 389	700	350	130	100	70	35	30	20

We would recommend preparing stock solutions with a concentration of 10 – 25% if the Lutensol TO types are to be used in the form of very dilute solutions or if they are to be mixed with other solutions. This makes it very much easier to dilute them later on.

The rate at which the Lutensol TO types dissolve can be increased by adding alcohols, glycols and other solubilizers.

The Lutensol TO types can form fairly stiff gels at certain concentrations when water is added. The figures below were measured with a Brookfield viscometer at 23 °C and 60 rpm.

The viscosity of selected Lutensol TO types as a function of concentration (in mPa·s)

Water content (%)	Lutensol					
	TO 2	TO 3	TO 5	TO 6	TO 65	TO 7
<b>10</b>	50	70	80	110	120	120
<b>20</b>	100	80	140	4000	150	>10 <sup>5</sup>
<b>30</b>	130	160	30000	33000	35000	>10 <sup>5</sup>
<b>40</b>	120	200	30000	6000	40000	>10 <sup>5</sup>
<b>50</b>	100	200	>10 <sup>5</sup>	2000	28000	15000
<b>60</b>	70	200	>10 <sup>5</sup>	1000	8000	170
<b>70</b>	20	200	30000	300	2500	180
<b>80</b>	10	30	1000	200	700	270
<b>90</b>	10	20	280	70	150	80

Water content (%)	Lutensol					
	TO 79	TO 8	TO 89	TO 10	TO 109	TO 11
<b>10</b>	>10 <sup>5</sup>	170	>10 <sup>5</sup>	160	>10 <sup>5</sup>	150
<b>20</b>	>10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>	250	>10 <sup>5</sup>	200
<b>30</b>	>10 <sup>5</sup>	>10 <sup>5</sup>	27000	>10 <sup>5</sup>	>10 <sup>5</sup>	1000
<b>40</b>	15000	27000	70000	850	>10 <sup>5</sup>	>10 <sup>5</sup>
<b>50</b>	170	70000	>10 <sup>5</sup>	>10 <sup>5</sup>	500	>10 <sup>5</sup>
<b>60</b>	180	>10 <sup>5</sup>	350	>10 <sup>5</sup>	250	>10 <sup>5</sup>
<b>70</b>	270	350	30	150	100	800
<b>80</b>	80	30	20	20	30	200
<b>90</b>	50	20	10	10	20	30

Water content (%)	Lutensol				
	TO 12	TO 129	TO 15	TO 20	TO 389
<b>10</b>	220	450	160	200	120
<b>20</b>	310	5000	200	250	10000
<b>30</b>	630	>10 <sup>5</sup>	600	1200	12000
<b>40</b>	>10 <sup>5</sup>	10000	>10 <sup>5</sup>	>10 <sup>5</sup>	10000
<b>50</b>	>10 <sup>5</sup>	300	>10 <sup>5</sup>	>10 <sup>5</sup>	1000
<b>60</b>	3860	100	600	>10 <sup>5</sup>	500
<b>70</b>	100	50	100	400	200
<b>80</b>	30	20	40	50	150
<b>90</b>	10	10	20	20	20

## Storage

- a) The Lutensol TO types should be stored indoors in a dry place. Storerooms must not be overheated.
- b) They are hygroscopic and readily soluble in water, with the result that they absorb moisture very quickly. Drums must be resealed each time they are opened.
- c) The storage temperature should not be allowed to fall substantially below 20 °C. The setting points of these products also need to be taken into account.
- d) Lutensol TO 2, TO 3, TO 5, TO 6, TO 65, TO 7, TO 79 and TO 8, are cloudy liquids at room temperature, and they tend to form a sediment. This cloudiness can be dissipated by heating them to approx. 50 °C.
- e) Liquid that has solidified or that shows signs of sedimentation should be heated to 50 – 70 °C and homogenized before it is processed.
- f) Drums that have solidified or that have begun to precipitate should be reconstituted by gentle heating, preferably in a heating cabinet. The temperature must not be allowed to exceed 70 °C. This also applies if drums are heated by external electrical elements.  
  
Internal electrical elements should not be used because of the localized anomalies in temperature that they cause.
- g) The Lutensol TO types must be blanketed with nitrogen if they are stored in heated tanks (at 50 – 70 °C) to prevent them from coming into contact with air. Constant, gentle stirring helps to prevent them being discoloured as a result of prolonged contact with electrical elements or external heating coils.

## Materials

The following materials can be used for tanks and drums.

- a) AISI 321 stainless steel (X6 CrNiTi 1810)
- b) AISI 316 Ti stainless steel (X10 CrNiMoTi 1810)

## Shelf life

The Lutensol TO types have a shelf life of at least two years in their original packaging, provided they are stored properly and drums are kept tightly sealed.

## Applications

The Lutensol TO types belong to a group of nonionic surfactants that have established themselves in detergents and cleaners, and in other branches of the chemical industry, by virtue of the high levels of surface activity that they display. Their main area of application is in detergents and cleaners for household, industrial and institutional use.

Because they are nonionic, the Lutensol TO types can be combined very effectively with anionic, cationic and nonionic surfactants and auxiliaries. They are fully compatible with alkylaryl sulphonates (Lutensit® TC-ALB types), ether sulphates (Lutensit® AS 2230) and other sulphated and sulphonated products. This enables synergistic effects and very high levels of performance to be obtained. They are also compatible with the Lutensit KLC types (cationic products based on dimethyl fatty alkylbenzene-ammonium chloride) and with other nonionic surfactants such as our Lutensol A N, AO, AP, AT, F, GD, ON, XA, XL and XP types, and with the low-foaming surfactants in our Plurafac® LF and our Pluronic® PE and RPE ranges. Their compatibility with dyes, pigments, protective colloids, thickeners and other substances with a molar mass in the upper range is also very good.

The versatility of the Lutensol TO types is such that they can be used to formulate acid, alkaline and neutral cleaners that satisfy the most varied demands. They are very effective emulsifiers in combination with Emulan® and other products from the Lutensol range.

## Laundry detergents

The Lutensol TO types and other similar nonionic surfactants have been gaining in importance in recent years, for the following reasons.

1. Detergent manufacturers have been working steadily for years to reduce the amount of pentasodium triphosphate (STP) in their products, or to eliminate it completely, for ecological reasons. The proportion of nonionic surfactants in detergent formulations, in terms of their total surfactant content, has had to be increased to compensate for the drop in performance caused by replacing STP with other builders. Fatty alcohol ethoxylates, especially those with a medium-length alkyl chain, have been shown to provide substantial increases in detergency in extensive trials.
2. Laundry detergents that contain predominately anionic surfactants are only really effective on cotton fabrics at high temperatures and at high concentrations. Detergents, especially all-temperature detergents, have to contain a large proportion of nonionic surfactants if they are to provide acceptable results on cotton, synthetic fibres and blended fabrics. The detergency of medium-chain fatty alcohol ethoxylates is substantially better than that of anionic surfactants, especially in the low-to-medium temperature range and at reduced concentrations.
3. Medium-chain fatty alcohol ethoxylates can be used to control foaming in household detergents. Their degree of ethoxylation can be in the lower or upper range, depending on the temperatures for which detergents are designed. Detergents are often expected to produce different amounts of foam at different temperatures, and this is normally achieved simply by adjusting the proportions of linear alkylbenzenesulphonate, fatty alcohol sulphate, soap and nonionic surfactants, but special antifoams can be added if required.
4. Nonionic surfactants with ca. 7 mol of EO are the best choice for liquid laundry detergents, because they are the most effective in the 60 °C temperature range. The popularity of Lutensol TO 7 and Lutensol TO 79 has been increasing in line with the increasing demand for household liquid detergents.

## High-temperature powders

We would recommend Lutensol TO 8, Lutensol TO 10, Lutensol TO 11 and Lutensol TO 12 for use at temperatures of up to 95 °C, either alone or in combination with Lutensol AO types.

## Machine-washing detergents for use at 60 °C

The Lutensol TO types with a medium degree of ethoxylation perform best at 60 °C, and they perform well in low-phosphate and phosphate-free formulations. We would therefore recommend using Lutensol TO 7, Lutensol TO 79, Lutensol TO 8 and Lutensol TO 89 here, either alone or in combination with Lutensol AO types.

Lutensol TO 389 has been shown to perform very well in low-foaming, low-phosphate and phosphate-free detergents and in institutional laundry detergents, either alone or in combination with Lutensol AO 3109.

Lutensol TO 389, TO 5, TO 6 and TO 65 have been shown to remove fatty soil very effectively in combination with Lutensol TO 8.

Combinations of Lutensol TO 5 or TO 6 and Plurafac® LF 403 can be employed in low-foaming institutional laundry detergents for use at 60 – 70 °C.

## Light-duty liquids and powders, detergents for wool, hand-washing detergents

Lutensol TO 7, TO 79, TO 8, TO 89 and TO 389 perform very well in detergents of this type in combination with Lutensol AO 3109 and Plurafac LF 400 or Plurafac LF 401.

## Cleaners

The Lutensol TO types have high detergency and high soil-dispersing capacity, and they are very effective emulsifiers and wetting agents. It is for this reason that they are frequently employed in detergents and cleaners and in other industrial processes that require this type of performance. The Lutensol TO types with a low degree of ethoxylation perform very well as emulsifiers for mineral oils, which is particularly useful in cleaners that are applied cold.

The Lutensol TO types with a degree of ethoxylation in the middle of the range perform particularly well in all-purpose cleaners and in cleaners for industrial, household and institutional use that are applied at higher temperatures.

Large amounts of acids, alkalis, salts and organic solvents may have to be added to some formulations in order to fulfil special requirements. High concentrations of inorganic salts, bases and acids can impair the solubility of the Lutensol TO types. Electrolytes of this type do not cause the Lutensol TO types to decompose, but they can cause surfactant solutions to become cloudy or to separate out. Nevertheless, the performance of solutions of Lutensol TO types is not affected by turbidity provided they are still homogeneous.

### Neutral cleaners

The water-soluble products in the range – Lutensol TO 8, TO 10, TO 12, TO 89, TO 109 and TO 129 – perform particularly well in neutral cleaners in combination with anionic surfactants from our Lutensit range (especially Lutensit TC-ALB types), dispersing agents (Sokalan® CP and PA types) and chelating agents (Trilon®). It can be advisable to add a solubilizer such as cumene sulphonate to highly concentrated formulations.

### Neutral metal cleaners

Neutral cleaners and degreasers with a corrosion-inhibiting action for metal pre-treatment can be formulated from products such as Korantin® MAT, Korantin PAT, Korantin PM and Korantin PP. The water-soluble surfactants in the range, especially Lutensol TO 8 or TO 89 and Lutensol TO 10 or TO 109, are very effective wetting agents for use in this type of formulation.

### Alkaline cleaners

Cleaners of this type are based on caustic alkalis and carbonates, silicates and phosphates. They are mainly used to clean metal before it is plated, coated, phosphatized or anodized. Lutensol TO 8, TO 10, TO 11 and TO 12 perform best, in combination with anionic surfactants such as Lutensit TC-APS 35 and Lutensit TC-ALB types, chelating agents (Trilon) and dispersing agents (Tanol® N types).

Lutensol TO 89, TO 109 and TO 129 can also be employed in liquid alkaline cleaners.

### Acid cleaners

Lutensol TO 8, TO 10, TO 11, TO 12, TO 89, TO 109 and TO 129 can be used in pickling solutions, degreasers, scalers and derusters based on hydrochloric, sulphuric, phosphoric or sulphamic acid. Formulations can also contain Lutensol FA 12 K, Lutensit TC-KLC 50 and corrosion inhibitors such as our Korantin BH types, Korantin PM and Korantin PP.

### Household cleaners

Household cleaners are mostly neutral, but they can be slightly alkaline or slightly acidic. They can be formulated with Lutensol TO 5, TO 6, TO 65, TO 7, TO 79, TO 8, TO 10, TO 11, TO 89 and TO 109 together with other anionic and nonionic surfactants, chelating agents (Trilon) and dispersing agents (Sokalan).

Lutensol TO 12, TO 15 and TO 20 can be used alongside our Pluriol E types as binders for solid cleaners.

### Solvent-based cleaners

Lutensol TO 3 and Lutensol TO 5 can be used alongside Emulan P to emulsify hydrocarbons such as kerosene and white mineral spirits in emulsion-type cleaners and solvent-based cleaners that are applied cold.

## Emulsification

The Lutensol TO types generally perform well as emulsifiers, although some perform better than others. Their practical performance as emulsifiers can be assessed according to their hydrophilic-lipophilic balance, which correlates with their degree of ethoxylation.

The Lutensol TO types can be combined with other emulsifiers from our nonionic Emulan and anionic Emulphor ranges, and with alkali soaps, amine soaps and sulphonated oils. Graduated tests are the most effective means of determining the best emulsifiers or combinations of emulsifiers and the amounts required. Tests are indispensable if emulsions are subjected to severe demands due to the presence of electrolytes, finely divided suspended solids or water-soluble, organic solvents. Special emulsifier combinations often have to be employed to cope with exceptional thermal or mechanical stress.

Lutensol TO 5, TO 6, TO 65, TO 7, TO 8, TO 10, TO 11, TO 12, TO 15, TO 20 and TO 389 can be used to emulsify aromatic solvents such as benzene, toluene, xylene and solvent naphtha.

Lutensol TO 7, TO 8, TO 10, TO 11, TO 12, TO 15 and TO 20 can be used in emulsion polymerization process to emulsify monomers such as styrene, acrylic and vinyl compounds, either alone or in combination with anionic emulsifiers such as Emulphor OPS 25.

## Dispersing

The dispersing capacity of surfactants, which plays an important part in cleaning and emulsification processes, can be their single most important attribute in situations in which sparingly soluble solids have to be dispersed in water, polar solvents or mixtures of water and solvents. The Lutensol TO types are effective dispersing agents in grinding and milling processes, and they can be used to disperse the solids generated by precipitation, coagulation and other chemical reactions. They can be used alone or in combination with protective colloids, depending on the particular application.

## Wetting

The Lutensol TO types are very effective wetting agents. They can be employed in many branches of industry in a variety of refining, mixing, impregnating and surface-treatment processes in aqueous media. No specific recommendations can be made on account of the diversity of these processes. Again, graduated tests under practical conditions are the most effective means of determining the best products for specific applications.

## Other applications

There are many other applications for the Lutensol TO types in the manufacture of leather, paper, paints and building products.

Lutensol TO 2 and Lutensol TO 3 can be employed as feedstocks in the production of ether sulphates.

## Substitutes for alkylphenol ethoxylates (APEO)

In July 2003, the European Parliament published Directive 2003/53/EC "....relating to restrictions on the marketing and use of certain dangerous substances and preparations (nonylphenol, nonylphenol ethoxylates...." in the Official Journal. This legislation was introduced in response to demands to minimise the risks posed by nonylphenol that were identified in the EU Risk Assessment.

This legislation has been in force since January 2005.

The directive covers all applications that result in discharges, emissions or losses to the environment and has the aim of minimising discharges of nonylphenol and nonylphenol ethoxylates into receiving waters. Nonylphenol and nonylphenol ethoxylates may only be brought into circulation at concentrations of less than 0.1% w/w as substances or as ingredients of preparations in applications in which they are discharged.

The applications that are affected by this directive include commercial cleaning, household cleaning and textile and leather processing.

These requirements also apply to products that are imported from outside Europe.

BASF supplies a variety of surfactants with comparable performance such as the Lutensol TO types which, along with the Lutensol XL and XP types, can be used as environmentally friendly alternatives.

## Safety

We know of no ill effects that could have resulted from using the Lutensol TO types for the purpose for which they are intended and from processing them in accordance with current practice.

According to the experience we have gained over many years and other information at our disposal, the Lutensol TO types do not exert any harmful effects on health, provided that they are used properly, due attention is given to the precautions necessary for handling chemicals, and the information and advice given in our safety data sheets are observed.

## Labelling

Please refer to the latest safety data sheets for detailed, up-to-date information on classification, labelling and product safety.

## Note

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