Technical Information

March 2013

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Pluronic® PE types

® = Registered trademark of BASF

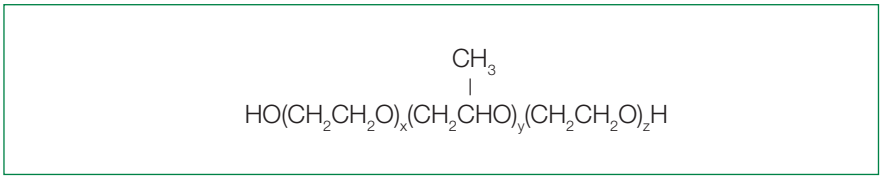
Pluronic® PE 3100
Pluronic® PE 3500
Pluronic® PE 4300
Pluronic® PE 6100
Pluronic® PE 6200
Pluronic® PE 6400
Pluronic® PE 6800
Pluronic® PE 8100
Pluronic® PE 9200
Pluronic® PE 9400
Pluronic® PE 10100
Pluronic® PE 10300
Pluronic® PE 10400
Pluronic® PE 10500
Pluronic® PE 10500 Solution

Low-foaming block copolymers for a wide variety of applications

BASF
The Chemical Company

Chemical nature

The Pluronic® PE types are low-foaming, nonionic surfactants. They are block copolymers in which the central polypropylene glycol group is flanked by two polyethylene glycol groups. They conform to the following structural formula.



Nomenclature

The Pluronic® PE types are designated by a four-figure or five-figure code. The first digit – or first two digits – is a guide to the molar mass of the hydrophobe, in this case polypropylene glycol, on a scale of 1 – 10. The second or third digit is the percentage of polyethylene glycol in the molecule, multiplied by 10.

Nomenclature of the Pluronic® PE types

Pluronic®	Code	Molar mass of polypropylene glycol block (g/mol)	Code	Percentage of polyethylene glycol in molecule (%)
PE 3100	3	950	1	10
PE 3500	3	950	5	50
PE 4300	4	1100	3	30
PE 6100	6	1750	1	10
PE 6200	6	1750	2	20
PE 6400	6	1750	4	40
PE 6800	6	1750	8	80
PE 8100	8	2300	1	10
PE 9200	9	2750	2	20
PE 9400	9	2750	4	40
PE 10100	10	3250	1	10
PE 10300	10	3250	3	30
PE 10400	10	3250	4	40
PE 10500	10	3250	5	50

PRD-Nos.*

Pluronic® PE 3100	30044078
Pluronic® PE 3500	30044083
Pluronic® PE 4300	30044084
Pluronic® PE 6100	30044126
Pluronic® PE 6200	30044130
Pluronic® PE 6400	30044133
Pluronic® PE 6800	30044097
Pluronic® PE 8100	30044087
Pluronic® PE 9200	30044105
Pluronic® PE 9400	30044106
Pluronic® PE 10100	30044111
Pluronic® PE 10300	30058297
Pluronic® PE 10400	30044093
Pluronic® PE 10500	30044121
Pluronic® PE 10500 Solution	30044112

* BASF's commercial product numbers.

Properties

The consistency of the individual products in the Pluronic® PE range is determined by their polyethylene glycol content and the molar mass of the central polypropylene glycol block. They tend to become more solid as these figures increase. Pluronic® PE 6800 is supplied in the form of fine, free-flowing, non-tacky beads for ease of processing.

The most important properties of the Pluronic® PE types are listed in the table overleaf.

The information below 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.

Pluronic® PE 3100	Clear, colorless liquid
Pluronic® PE 3500	Clear, colorless liquid
Pluronic® PE 4300	Clear, colorless liquids; the cloudiness at low temperatures can be reversed by heating
Pluronic® PE 6100	
Pluronic® PE 6200	
Pluronic® PE 6400	Colorless, slightly cloudy liquid
Pluronic® PE 6800	Fine, white powder
Pluronic® PE 8100	Colorless, clear or slightly cloudy liquids
Pluronic® PE 9200	
Pluronic® PE 9400	White, waxy solid
Pluronic® PE 10100	Colorless, clear or slightly cloudy liquid
Pluronic® PE 10300	White paste
Pluronic® PE 10400	White, waxy solid
Pluronic® PE 10500	White, waxy solid
Pluronic® PE 10500 Solution	Clear, colorless liquid

Pluronic®		**PE 3100**	**PE 3500**	**PE 4300**	**PE 6100**
Physical form (23 °C)		Liquid	Liquid	Liquid	Liquid
Molar mass, calculated from OH number	g/mol	approx. 1000	approx. 1900	approx. 1750	approx. 2000
Concentration	%	approx. 100	approx. 100	approx. 100	approx. 100
Cloud point (EN 1890)*					
Method A	°C	approx. 40	approx. 68		approx. 23
Method B	°C	approx. 33	approx. 58	approx. 40	
Method C	°C	approx. 26	approx. 50	approx. 31	
Method D	°C	approx. 45	approx. 79	approx. 65	approx. 37
Method E	°C	approx. 40	approx. 78	approx. 61	approx. 31
pH (EN 1262, Solution B)**		approx. 7	approx. 7	approx. 7	approx. 7
Density (DIN 51757, Method A, 23 °C)	g/cm³	approx. 1.02	approx. 1.05	approx. 1.03	approx. 1.02
Bulk density (ISO 697)	g/l				
Viscosity (EN 12092, 2 °C, Brookfield, 60 rpm)	mPa·s	approx. 175	approx. 450	approx. 400	approx. 350
Setting point (DIN 51583)	°C	approx. -15	approx. 12	approx. -10	approx. -30
Melting point	°C				
Wetting (EN 1772, 23 °C, 2 g/l soda ash, 1 g/l surfactant)	s	>300	>300	>300	>300
Surface tension*** (EN 14370, 1 g/l, 23 °C)	mN/m	approx. 44	approx. 45	approx. 42	approx. 40

* *Cloud point according to EN 1890:*
Method A: 1 g surfactant + 100 g distilled water
Method B: 1 g surfactant + 100 g NaCl solution (c = 50 g/l)
Method C: 1 g surfactant + 100 g NaCl solution (c = 100 g/l)
Method D: 5 g surfactant + 45 g ethylene glycol monobutyl ether solution (c = 250 g/l)
Method E: 5 g surfactant + 25 g ethylene glycol monobutyl ether solution (c = 250 g/l)

** *The pH of the Pluronic® PE types can fall slightly in storage, but this has no effect on their performance.*

*** *Applying Harkins-Jordan correction*

Pluronic®		**PE 6200**	**PE 6400**	**PE 6800**	**PE 8100**
Physical form (23 °C)		Liquid	Liquid	Powder	Liquid
Molar mass, calculated from OH number	g/mol	approx. 2450	approx. 2900	approx. 8000	approx. 2600
Concentration	%	approx. 100	approx. 100	approx. 100	approx. 100
Cloud point (EN 1890)*					
Method A	°C	approx. 33	approx. 60	>100	approx. 19
Method B	°C		approx. 50	approx. 88	
Method C	°C		approx. 40	approx. 72	
Method D	°C	approx. 60	approx. 70	approx. 90	approx. 42
Method E	°C	approx. 54	approx. 69	approx. 95	approx. 36
pH** (EN 1262, Solution B)		approx. 7	approx. 7	approx. 7	approx. 7
Density (DIN 51757, Method A, 23 °C)	g/cm³	approx. 1.04	approx. 1.05	approx. 1.06 (70 °C)	approx. 1.03
Bulk density (ISO 697)	g/l			approx. 600	
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	approx. 500	approx. 1000		approx. 700
Setting point (DIN 51583)	°C	approx. -12	approx. 16		approx. -30
Melting point	°C			approx. 48	
Wetting (EN 1772, 23 °C, 2 g/l soda ash, 1 g/l surfactant)	s	>300	>300	>300	approx. 70
Surface tension*** (EN 14370, 1 g/l, 23 °C)	mN/m	approx. 41	approx. 41	approx. 51	approx. 35

* *Cloud point according to EN 1890:*
Method A: 1 g surfactant + 100 g distilled water
Method B: 1 g surfactant + 100 g NaCl solution (c = 50 g/l)
Method C: 1 g surfactant + 100 g NaCl solution (c = 100 g/l)
Method D: 5 g surfactant + 45 g ethylene glycol monobutyl ether solution (c = 250 g/l)
Method E: 5 g surfactant + 25 g ethylene glycol monobutyl ether solution (c = 250 g/l)

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*** *Applying Harkins-Jordan correction*

Pluronic®		**PE 9200**	**PE 9400**	**PE 10100**	**PE 10300**
Physical form		Liquid	Waxy solid	Liquid	Paste
Molar mass, calculated from OH number	g/mol	approx. 3650	approx. 4600	approx. 3500	approx. 4950
Concentration	%	approx. 100	approx. 100	approx. 100	approx. 100
Cloud point (EN 1890)					
Method A	°C	approx. 22	approx. 79	approx. 17	approx. 42
Method B	°C	–	approx. 67	–	approx. 32
Method C	°C	–	approx. 55	–	–
Method D	°C	approx. 40	approx. 77	approx. 40	approx. 67
Method E	°C	approx. 49	approx. 80	approx. 35	approx. 69
pH value** (EN 1262, Solution B)		approx. 7	approx. 7	approx. 7	approx. 7
Density (DIN 51757,) Method A, 23 °C	g/cm³	approx. 1.03	approx. 1.03	approx. 1.02	approx. 1.02 (60 °C)
Bulk density (ISO 697)	g/l	–	–	–	–
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	approx. 900	–	approx. 800	approx. 1800
Setting point (DIN 51583)	°C	approx. -3	–	approx. -25	approx. 15
Melting point	°C	–	approx. 32	–	–
Wetting (EN 1772, 23 °C, 2 g/l soda ash, 1 g/l surfactant)	s	>100	>300	approx. 60	approx. 70
Surface tension*** (EN 14370, 1 g/l, 23 °C)	mN/m	approx. 35	approx. 42	approx. 36	approx. 37

* *Cloud point according to EN 1890:*
Method A: 1 g surfactant + 100 g distilled water
Method B: 1 g surfactant + 100 g NaCl solution (c = 50 g/l)
Method C: 1 g surfactant + 100 g NaCl solution (c = 100 g/l)
Method D: 5 g surfactant + 45 g ethylene glycol monobutyl ether solution (c = 250 g/l)
Method E: 5 g surfactant + 25 g ethylene glycol monobutyl ether solution (c = 250 g/l)

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*** *Applying Harkins-Jordan correction*

Pluronic®		PE 10400	PE 10500	PE 10500 Solution
Physical form		Waxy solid	Waxy solid	Waxy solid
Molar mass, calculated from OH number	g/mol	approx. 5900	approx. 6500	approx. 6500
Concentration	%	approx. 100	approx. 100	approx. 18
Cloud point (EN 1890)				
Method A	°C	approx. 81	>100	>100
Method B	°C	approx. 61	approx. 75	approx. 75
Method C	°C	approx. 50	–	–
Method D	°C	approx. 78	–	–
Method E	°C	approx. 81	–	–
pH value** (EN 1262, Solution B)		approx. 7	approx. 7	approx. 7
Density (DIN 51757,) Method A, 23 °C	g/cm³	approx. 1.03 (60 °C)	approx. 1.03 (60 °C)	approx. 1.0
Bulk density (ISO 697)	g/l	–	–	–
Viscosity (EN 12092, 23 °C, Brookfield, 60 rpm)	mPa·s	–	–	approx. 10
Setting point (DIN 51583)	°C	–	–	approx. -9
Melting point	°C	approx. 34	approx. 44	
Wetting (EN 1772, 23 °C, 2 g/l soda ash, 1 g/l surfactant)	s	approx. 85	approx. 300	>300
Surface tension*** (EN 14370, 1 g/l, 23 °C)	mN/m	approx. 38	approx. 39	approx. 39

* *Cloud point according to EN 1890:*
Method A: 1 g surfactant + 100 g distilled water
Method B: 1 g surfactant + 100 g NaCl solution (c = 50 g/l)
Method C: 1 g surfactant + 100 g NaCl solution (c = 100 g/l)
Method D: 5 g surfactant + 45 g ethylene glycol monobutyl ether solution (c = 250 g/l)
Method E: 5 g surfactant + 25 g ethylene glycol monobutyl ether solution (c = 250 g/l)

** *The pH of the Pluronic® PE types can fall slightly in storage, but this has no effect on their performance.*

*** *Applying Harkins-Jordan correction*

Solubility

It is a general rule that the solubility of Pluronic® PE types in water increases in step with the proportion of polyethylene glycol that they contain. If two products contain the same mass fraction of polyethylene glycol, the molar mass of the polypropylene glycol block is the determining factor, and the one with the lower molar mass will be the more soluble.

For instance, Pluronic® PE 6800 is more soluble in water than Pluronic® PE 6100, which is less soluble than Pluronic® PE 3100.

All of the Pluronic® PE types are more soluble in cold water than in hot water. As in all alkoxylates, the oxygen atoms in the ether groups form hydrogen bonds with water. The molecules gradually dissociate as the solution warms up. It is for this reason that alkoxylates have a cloud point at which they form a separate phase. Each product in the Pluronic® PE range has its own characteristic cloud point.

The solubility of the various Pluronic® PE types in different solvents is shown below.

Solubility of Pluronic® PE types at 23 °C (10% solutions)

Pluronic®	PE 3100	PE 3500	PE 4300	PE 6100	PE 6200
Distilled water	–	+	+	–	+
Caustic soda, 10%	–	+	–	–	–
Hydrochloric acid, 10%	–	+	+	–	+
Ethanol	+	+	+	+	+
Isopropanol	+	+	+	+	+
Toluene	+	+	+	+	+ opalescent
White mineral spirits	+	–	–		–

Pluronic®	PE 6400	PE 6800	PE 8100	PE 9200	PE 9400
Water	+	+	–	+ opalescent	+ opalescent
Caustic soda, 10%	–	–	–	–	–
Hydrochloric acid, 10%	+	+	–	+ opalescent	+
Ethanol	+	+	–	+	+
Isopropanol	+	–	+	+	+
Toluene	+	+	+	+	+
White mineral spirits	–	–	–	–	–

Pluronic®	PE 10100	PE 10300	PE 10400	PE 10500	PE 10500 Solution
Water	–	–	–	+	+
Caustic soda, 10%	–	–	–	–	+
Hydrochloric acid, 10%	+	–	–	+	+
Ethanol	+	+	+	+	+
Isopropanol	+	+	+	+	+
Toluene	+	+	+	+ opalescent	–
White mineral spirits	–/+	–	–	–	–

+ = *Soluble*
– = *Insoluble*

Wetting

The most effective wetting agents contain a low proportion of polyethylene glycol, and their central polypropylene glycol block has a high molar mass. The best wetting agents in the range are Pluronic® PE 8100, PE 9200 and PE 10100.

Compatibility

The Pluronic® PE types are nonionic and therefore miscible with anionic, cationic and other nonionic surfactants. They do not react with cations such as Ca^{2+} or Mg^{2+}, which means that they can be used in hard water. They are also compatible with soluble polyanionic substances such as our Sokalan® CP types, Sokalan® PA types and carboxymethyl cellulose.

The Pluronic® PE types are fully resistant to non-oxidizing acids at the concentrations at which they are normally employed in applications such as those described below but, although they are resistant to alkalis, they are not resistant to alkalis to quite the same extent.

Processing

It is advisable to stir the surfactant into water when preparing aqueous solutions, because solutions made up in the reverse order can have a very high viscosity. Products with a high molar mass also form gels in water at certain concentrations. The relationship between viscosity and concentration is shown in the table below.

The viscosities of aqueous solutions of Pluronic® PE types in mPa·s (approx.)
(The values below were measured at 25 °C with a Brookfield viscometer)

Pluronic®	PE 3100	PE 3500	PE 4300	PE 6100	PE 6200
Water content (%)					
0	175	440	400	350	500
10	170	450	600	380	600
20	130	360	750	350	650
30	110	215	9000	200	450
40	90	110	400	250	300
50	60	50	150	100	200
60	25	25	40	50	50
70	10	10	10	<10	20
80	<10	<10	<10	<10	<10
90	<10	<10	<10	<10	<10

Pluronic®	PE 6400	PE 6800	PE 8100	PE 9200	PE 9400
Water content (%)					
0	1000	Powder	700	900	$>10^5$
10	1300	$>10^5$	1000	70000	$>10^5$
20	30000	$>10^5$	1600	$>10^5$	$>10^5$
30	40000	$>10^5$	1800	$>10^5$	$>10^5$
40	$>10^5$	$>10^5$	2100	$>10^5$	$>10^5$
50	$>10^5$	2000	1200	$>10^5$	$>10^5$
60	1000	280	500	$>10^5$	$>10^5$
70	20	60	400	13000	$>10^5$
80	<10	30	50	1200	30
90	<10	20	10	20	30

Pluronic®	PE 10100	PE 10300	PE 10400	PE 10500	PE 10500 Solution
Water content (%)					
0	800	1800	$>10^5$	$>10^5$	10
10	3300	$>10^5$	$>10^5$	$>10^5$	10
20	$>10^5$	$>10^5$	$>10^5$	$>10^5$	10
30	$>10^5$	$>10^5$	$>10^5$	$>10^5$	10
40	$>10^5$	$>10^5$	$>10^5$	$>10^5$	10
50	$>10^5$	$>10^5$	$>10^5$	$>10^5$	<10
60	12000	$>10^5$	$>10^5$	$>10^5$	<10
70	2300	65	$>10^5$	$>10^5$	<10
80	1100	15	35	3200	<10
90	30	<10	<10	10	<10

The relationship between the viscosities of the Pluronic® PE types in mPa·s (approx.) and temperature is shown in the following table.

Pluronic® PE	3100	3500	4300	6100	6200	6400	6800	8100
Temperature (°C)								
0	1000	$>10^5$	10000	1800	2400	$>10^5$	–	3000
10	300	$>10^5$	2000	900	1200	65000	–	1700
20	200	1200	700	400	500	1000	–	800
30	100	300	300	220	300	500	–	400
40	60	190	200	130	200	300	–	240
50	40	130	120	80	130	200	–	160
60	20	90	80	40	80	100	5000	100

Pluronic® PE	9200	9400	10100	10300	10400	10500	10500 Solution
Temperature (°C)							
0	13500	$>10^5$	5200	$>10^5$	$>10^5$	$>10^5$	20
10	1500	$>10^5$	2500	$>10^5$	$>10^5$	$>10^5$	15
20	900	$>10^5$	1200	$>10^5$	$>10^5$	$>10^5$	15
30	500	$>10^5$	500	700	$>10^5$	$>10^5$	10
40	300	600	350	430	$>10^5$	$>10^5$	<10
50	200	400	200	280	800	800	<10
60	120	300	150	200	500	500	<10

Storage

a) The Pluronic® PE types should be kept tightly sealed in a dry place in their tightly sealed original packaging. Storerooms must not be overheated.

b) The Pluronic® PE types are hygroscopic and soluble in water, with the result that they absorb moisture very quickly. Drums should be tightly resealed each time material is taken from them.

c) The Pluronic® PE types should not be stored at temperatures substantially below 20 °C.

d) The Pluronic® PE types can become cloudy liquids at low temperatures and/or after long periods in storage, and this can cause them to form a sediment.

This cloudiness is reversible at 50 – 70 °C. Reconstitution has no effect on their practical performance.

e) Liquid that has solidified or that shows signs of precipitation should be heated to 50 – 70 °C and homogenized before use.

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 50 °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 Pluronic® PE types must be blanketed with nitrogen if they are stored in heated tanks (at approx. 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.

h) Pluronic® PE 6800 should be stored in a dry place at a temperature not exceeding 25 – 30 °C. It must be protected from sunlight to ensure that it does not form lumps.

Materials

The Pluronic® PE types should be stored in tanks made from the following materials.

a) AISI 316 Ti stainless steel

b) AISI 321 stainless steel

Shelf life

The Pluronic® PE types have a shelf life of at least two years, provided they are stored in their original packaging and kept tightly sealed.

Safety

We know of no ill effects that could have resulted from using the Pluronic® PE 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 Pluronic® PE 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 latest Safety Data Sheet for detailed information on product safety.

Note

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