Technical Information

TI/ES 1026 e
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Pluronic® PE types

® = Registered trademark of
BASF Aktiengesellschaft

Pluronic PE 3100
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 10500

Low-foaming block copolymers for a wide variety of applications

Specialty Chemicals

BASF

Pluronic PE types

The Pluronic PE range comprises the following products:

Pluronic PE 3100
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 10500

German chemicals legislation based on EU Directive 67/548/EEC does not require these products to be labelled.

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 number. 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, divided by ten.

Nomenclature of the Pluronic PE types

Pluronic	First digit(s)	Molar mass of polypropylene glycol block (g/mol)	Second or third digit	Percentage of polyethylene glycol in molecule (%)
PE 3100	3	850	1	10
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 10500	10	3250	5	50

Properties

The consistency of the individual products in the 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 below.

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	PE 4300	PE 6100	PE 6200
Physical form		Liquid	Liquid	Liquid	Liquid
Molar mass, calculated from OH number	g/mol	ca. 1000	ca. 1750	ca. 2000	ca. 2450
Concentration	%	ca. 100	ca. 100	ca. 100	ca. 100
		$HO(CH_2CH_2O)_x(CH(CH_3)CH_2O)_y(CH_2CH_2O)_zH$			
Cloud point (DIN 53917)					
in BDG	°C	ca. 40	ca. 61	ca. 31	ca. 54
in water	°C	ca. 40	ca. 40	ca. 23	ca. 33
in saline solution	°C	ca. 33			
pH (5 % in water)*		ca. 7	ca. 7	ca. 7	ca. 7
Density (23 °C)	g/cm^3	ca. 1.02	ca. 1.0	ca. 1.02	ca. 1.04
Bulk density	g/l				
Viscosity (23 °C, Brookfield, 60 rpm)	mPa·s	ca. 175	ca. 400	ca. 350	ca. 500
Setting point	°C	ca. –15	ca. –10	ca. – 30	ca. –12
Melting point	°C				
Wetting (DIN 53901, in distilled water with 2 g/l soda ash, 23 °C)	s	>300	>300	>300	>300
Surface tension ** (DIN 53914, 1 g/l in destilled water at 23 °C)	mN/m	ca. 44	ca. 42	ca. 40	ca. 41

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

*** Applying Harkins-Jordan correction*

Pluronic PE 3100	Clear, colourless liquid
Pluronic PE 4300	Clear, colourless liquids; the
Pluronic PE 6100	cloudiness at low temperatures can
Pluronic PE 6200	be reversed by heating
Pluronic PE 6400	Colourless, slightly cloudy liquid
Pluronic PE 6800	Fine, white powder
Pluronic PE 8100	Colourless, clear or slightly cloudy
Pluronic PE 9200	liquids
Pluronic PE 9400	White, waxy solid
Pluronic PE 10100	Colourless, clear or slightly cloudy liquid
Pluronic PE 10500	White, waxy solid

PE 6400	PE 6800	PE 8100	PE 9200	PE 9400	PE 10100	PE 10500
Liquid	Powder	Liquid	Liquid	Waxy solid	Liquid	Waxy solid
ca. 2900	ca. 8000	ca. 2600	ca. 3650	ca. 4600	ca. 3500	ca. 6500
ca. 100	ca. 100	ca. 100	ca. 100	ca. 100	ca. 100	ca. 100
ca. 69	ca. 95	ca. 36	ca. 49	ca. 80	ca. 35	
ca. 60	>100	ca. 19	ca. 22		ca. 17	>100
ca. 50	ca. 88					ca. 75
ca. 7	ca. 7	ca. 7	ca. 7	ca. 7	ca. 7	ca. 7
ca. 1.05	ca. 1.06 (70 °C)	ca. 1.03	ca. 1.03	ca. 1.03 (60 °C)	ca. 1.02	ca. 1.03 (60 °C)
	ca. 600					
ca. 1000		ca. 700	ca. 900		ca. 800	
ca. 16		ca. – 30	ca. – 3		ca. – 25	
	ca. 48			ca. 32		ca. 44
>300	>300	ca. 70	ca. 100	>300	ca. 60	ca. 300
ca. 41	ca. 51	ca. 35	ca. 35	ca. 42	ca. 36	ca. 39

Solubility

It is a general rule that the solubility of Pluronic PE types in water increases in step with the proportion of polyethylene glycol 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 Pluronic PE types are more soluble in cold water than in hot water. As with all alkoxylates, the oxygen atoms in their 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 4300	PE 6100	PE 6200	PE 6400
Distilled water	–	+	–	+	+
Caustic soda, 10 %	–	–	–	–	–
Hydrochloric acid, 10 %	–	+	–	+	+
Ethanol	+	+	+	+	+
Isopropanol	+	+	+	+	+
Toluene	+	+	+	+ opalescent	+
Mineral spirits	+	–	+	–	–

Pluronic	PE 6800	PE 8100	PE 9200	PE 9400	PE 10100	PE 10500
Distilled water	+	–	+ opalescent	+ opalescent	–	+
Caustic soda, 10 %	–	–	–	–	–	–
Hydrochloric acid, 10 %	+	–	+ opalescent	+	+	+
Ethanol	+	–	+	+	+	+
Isopropanol	–	+	+	+	+	+
Toluene	+	+	+	+	+	+ opalescent
Mineral spirits	–	–	–	–	–/+	–

+ = Soluble
– = Insoluble

Wetting

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

Compatibility

The Pluronic PE types are nonionic, and are 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. Soluble polyanionic substances such as our Sokalan® CP types, Sokalan PA types or carboxymethyl cellulose do not cause any compatibility problems.

The Pluronic PE types are fully resistant to acids at the concentrations at which they are normally employed in applications such as those described below, but 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. Solutions made up in the reverse order can have a much higher 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 Water content (%)	PE 3100	PE 4300	PE 6100	PE 6200	PE 6400
0	175	400	350	500	1000
10	170	600	380	600	1300
20	130	750	350	650	30000
30	110	9000	200	450	40000
40	90	400	250	300	$>10^5$
50	60	150	100	200	$>10^5$
60	25	40	50	50	1000
70	10	10	<10	20	20
80	<10	<10	<10	<10	<10
90	<10	<10	<10	<10	<10

Pluronic Water content (%)	PE 6800	PE 8100	PE 9200	PE 9400	PE 10100	PE 10500
0	Powder	700	900	Paste	800	Paste
10	Paste	1000	70000	Paste	3300	Paste
20	Paste	1600	$>10^5$	Paste	Paste	Paste
30	Paste	1800	$>10^5$	Paste	Paste	Paste
40	Gel	2100	$>10^5$	Paste	Paste	Paste
50	2000	1200	$>10^5$	Paste	Paste	Paste
60	280	500	$>10^5$	Paste	12000	Paste
70	60	400	13000	Paste	2300	Paste
80	30	50	1200	30	1100	3200
90	20	10	20	30	30	10

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

Pluronic Tempe- rature (°C)	PE 3100	PE 4300	PE 6100	PE 6200	PE 6400	PE 6800	PE 8100	PE 9200	PE 9400	PE 10100	PE 10500
0	1000	10000	1800	2400	$>10^5$	–	3000	13500	$>10^5$	5200	$>10^5$
10	300	2000	900	1200	65000	–	1700	1500	$>10^5$	2500	$>10^5$
20	200	700	400	500	1000	–	800	900	$>10^5$	1200	$>10^5$
30	100	300	220	300	500	–	400	500	$>10^5$	500	$>10^5$
40	60	200	130	200	300	–	240	300	600	350	$>10^5$
50	40	120	80	130	200	–	160	200	400	200	800
60	20	80	40	80	100	5000	100	120	300	150	500

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 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 – 60 °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 – 60 °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 ca. 50 °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 AISI 316 Ti or 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.

Applications

The polyethylene glycol content and the molar mass of the central polypropylene glycol block of these products can be varied within wide limits. The result is that surfactants of this type are exceptionally versatile. They can be tailored to boost their wetting, dispersing or emulsifying properties as the situation requires. They can be used to reduce foam or eliminate it altogether, and they can be used as solubilizers and thickeners.

Their ability to act as impregnating agents, humectants, plasticizers and lubricants can be exploited in a variety of situations. They can be used to adjust the viscosity of other liquids, to make tacky substances more coherent, and to disperse suspended solids. They can also be employed as heat transfer fluids and hydraulic fluids in some applications.

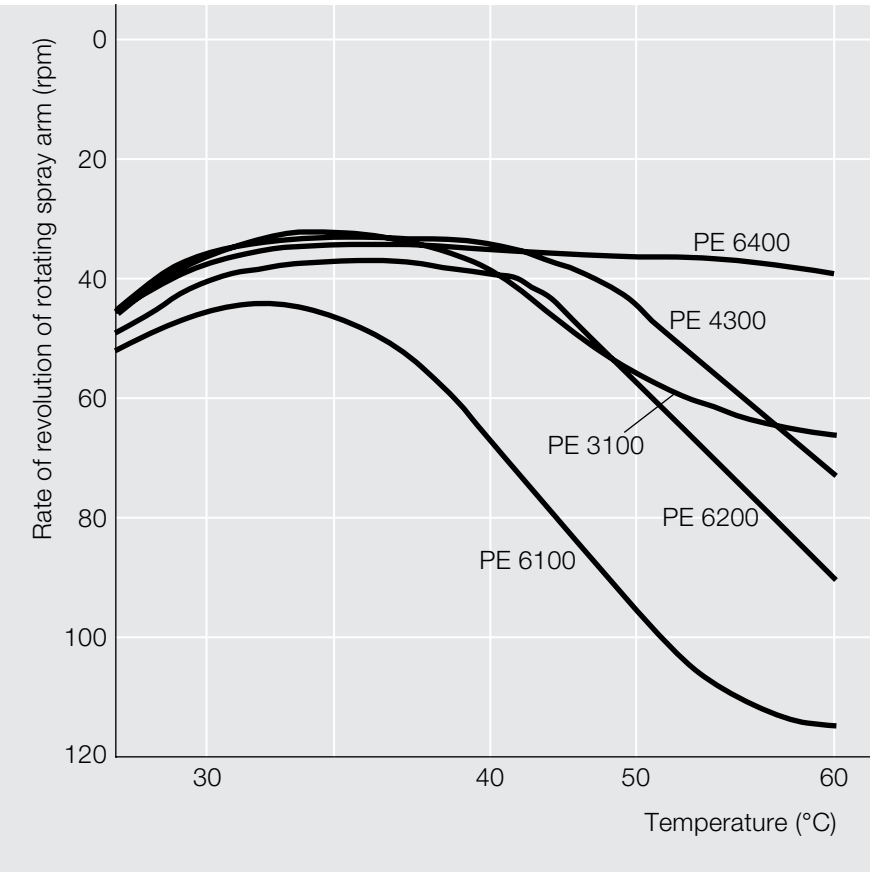
The Pluronic PE types can be used in detergents and cleaners – in the dairy, brewery and soft drinks sectors, for instance –, in cleaners that are sprayed onto metal parts to remove shavings and swarf, in the rubber and plastics industries, and in other branches of industry.

Foaming

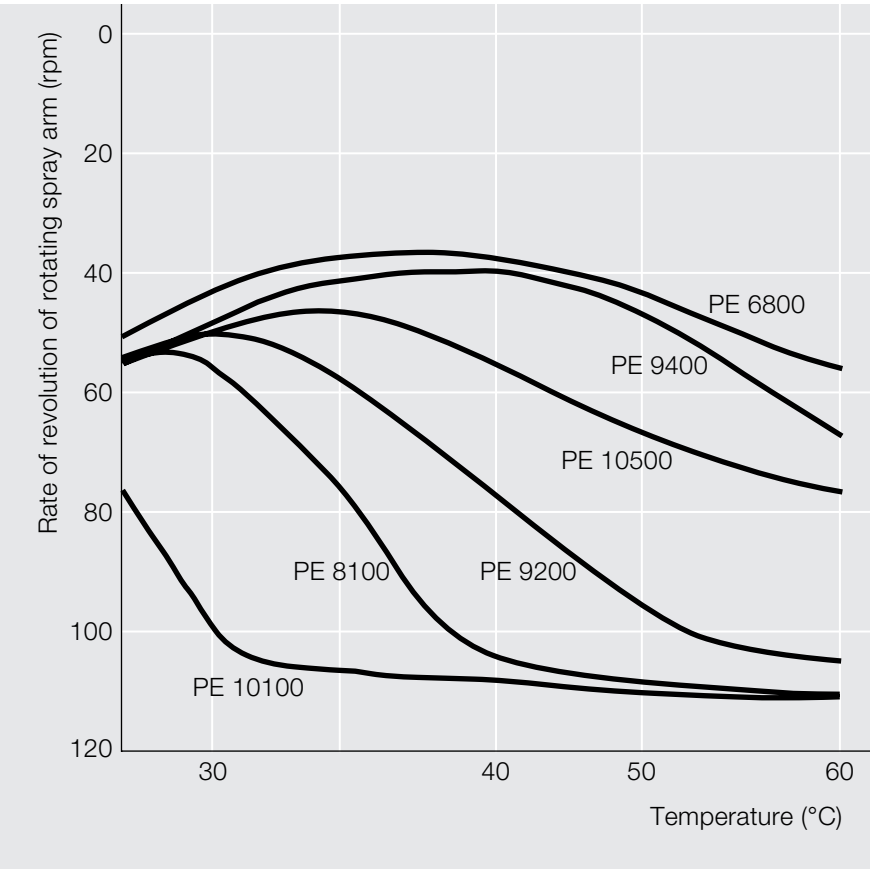
The Pluronic PE types do not foam or, at most, they are very low-foaming. The amount of foam formed decreases in line with their polyethylene glycol content. Pluronic PE types that contain less than 20 % polyethylene glycol can be employed as antifoams.

It is difficult to predict the foaming behaviour of surfactants in advance with standard test methods because of the influence of the type of soil and machinery, different temperature settings and the effects of the other ingredients in the formulation. The beater method described in DIN 53902, Part 1, or the Ross-Miles method described in ASTM D 1175-53 have to be substantiated with methods that correspond more closely to real conditions.

An effective method is to measure the level of foam produced in a dishwasher, because this closely corresponds to the conditions encountered in practice. The rotating spray arm is slowed down by foam: the higher the rate of revolution, the less foam is present. Foam formation can be encouraged by adding protein.



Foam curves for the Pluronic PE types



Foam curves for the Pluronic PE types

The best antifoams at all temperatures are Pluronic PE 6100, PE 8100 and PE 10100, all of which are insoluble in water at room temperature.

Pluronic PE 3100

Pluronic PE 3100 can be used to disperse dyes and pigments, and it can be employed as an antifoam in many situations.

Pluronic PE 4300

Pluronic PE 4300's main area of application is in dishwasher detergents and rinse aids, either alone or in combination with other Pluronic PE types. It is low-foaming, and it often performs very well in combination with Pluronic 3100.

Pluronic PE 6100

Pluronic PE 6100 can be employed in situations in which foaming is a nuisance, such as in domestic dishwashers and industrial bottle-washing machines. It suppresses foam very well, even in the presence of protein, starch or size. It is sometimes advisable to use it in combination with Plurafac® LF types or other Pluronic PE types.

Pluronic PE 6100 can also be used to defoam metal cleaning baths, acid dye baths and boiler feed water.

Pluronic PE 6200

Pluronic PE 6200 is an effective, low-foaming wetting agent. It is mainly used in mechanical cleaning processes. It can be employed in rinse aids to allow water to run off glass and crockery more easily, and to improve their gloss. Its high wetting power is particularly useful in phosphating baths.

It can be used to emulsify vinyl and acrylic monomers in polymerization processes, and it can also be used to break crude-oil emulsions.

Pluronic PE 6400

Pluronic PE 6400 has the highest detergency of all the products in the Pluronic PE range, and it is low-foaming. It performs particularly well in applications that involve intensive mechanical action, i. e. in dishwashers and industrial bottle-washing machines. It can also be used in dairy cleaners.

Pluronic PE 6400 has a very high dispersing capacity for sparingly soluble calcium and magnesium salts.

Other areas of application include cutting and grinding fluids for metal, where it acts as a lubricant and coolant. Like Pluronic PE 6200, it is used as an emulsifier in polymerization processes.

Pluronic PE 6800

Pluronic PE 6800 is supplied in the form of very fine beads. It is an appropriate choice for powder-type detergents and cleaners if surfactants cannot be sprayed on in liquid or paste from. It is easy to blend with other powders, and it has the added advantage of preventing dusting.

It can be used to disperse suspended calcium and magnesium salts, and to remove and disperse soil in acid pickling baths. Because it is nonionic, it can be used for cleaning metal electrolytically.

It can also be employed to solubilise essential oils and to emulsify monomers.

Pluronic PE 8100

Pluronic PE 8100 can be employed as a detergent and antifoam in cleaning applications in which a high level of mechanical energy needs to be applied. Synergistic effects can often be obtained if it is combined with other low-foaming surfactants. Typical areas of application include dishwasher detergents, cleaners for the dairy and brewery sectors, and rinse aids.

Pluronic PE 9200

Pluronic PE 9200 can be used in all cleaning processes in which quick, thorough wetting is essential. It can be used in household and institutional dishwasher detergents, either alone or in combination with Plurafac LF or other Pluronic PE types. Pluronic PE 9200 can be added to acidic rinse aids to prevent dull spots and streaks being formed by water droplets, and it imparts a high gloss to crockery and glass.

Pluronic PE 9400

Pluronic PE 9400 is used as an emulsifier for mineral oil and for dispersing solids in water.

It can be used together with other Pluronic PE types in dishwashers, bottle-washing machines, dairy equipment and in other applications of this type that involve intensive mechanical action. Like many other products in the Pluronic PE range, it has a high dispersing capacity for calcium and magnesium salts.

Pluronic PE 10100

Pluronic PE 10100 is an effective wetting agent for use in dishwasher detergents and rinse aids. It is very low-foaming, and it suppresses the foam formed by other surfactants.

It can also be employed as a demulsifier.

Pluronic PE 10500

Many different types of household and industrial cleaners can be formulated with mixtures of Pluronic PE 10500 and other Pluronic PE types, Pluronic RPE 3110 or Plurafac LF types.

This product is also employed as an emulsifier for monomers and for pesticides.

Formulations

Suggested formulations containing Pluronic PE types are given in the following Technical Information leaflets.

Dishwasher detergents (TI/ES 1187)
Specialty chemicals for metal pretreatment (TI/ES 1038)

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.

Handling

All contact with the eyes and prolonged contact with the skin should be avoided. Safety glasses must be worn when handling these products in their undiluted form. Air extraction equipment should be available if there is a danger of aerosols being formed.

Further information is given in our Safety Data Sheets.

Ecology

The rates at which polymers of this type are broken down by biological action are inversely proportional to their molar mass. Some products may fail to satisfy the requirements of the legislation governing the biodegradability of surfactants that applies in different countries.

However, there are many areas of application in which legislation does not apply to block copolymers of this type.

Labelling

No labelling is necessary for any of the Pluronic PE types under European legislation, and they are not required to be labelled as “Dangerous for the environment”.

Note

The information submitted in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application, these data do not relieve processors of the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.

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