MOMENTIVE
performance materials

Process Additives
Baysilone* Fluids P

Our Program

Baysilone* Fluids P are a group of polymeric methylphenyl siloxanes. They differ from the polydimethyl siloxanes of the Baysilone Fluids M range not only in their chemical structure but also in certain properties. Of particular note are their:

- Excellent thermal stability.
- Compatibility with numerous organic substances.
- High radiation resistance.
- Better lubricating properties.

Their other properties are similar to those of Baysilone Fluids M, which are pure polydimethyl siloxanes. These properties include:

- Relatively low effect of temperature on viscosity.
- Chemical inertness.
- Good dielectric values.
- Low pour point.
- Surface activity.

Selector Tool

Grades	Viscosity in $mm^2 \cdot s^{-1}$			Main applications
	25°C	60°C	100°C	
1. PN grades				Heat transfer media; lubricants for use at high temperatures; base oils for heat-resistant; lubricating greases, in particular PH grades
PN 200	200	80	38	
PN 1000	1000	330	130	
2. PH grades				
PH 300	300	82	28	
PH 1000	1000	205	60	
3. PD grade				Damping fluid; fluid for low-temperature resistant lubricating greases; fluid for cosmetic preparations.
PD 5	4	2	1	
4. PK grade				Use in cosmetic preparations.
PK 20	20	9	5	

Table 1: Viscosity of Baysilone Fluids P at different temperatures in $mm^2 \cdot s^{-1}$ (cSt).

Viscosity tolerances are ±10% for the PN and PH grades and ±20% for the other grades. Below is a summary of the most important physical and chemical properties of Baysilone Fluids P.

Viscosity

of Baysilone Fluids P at various temperatures is shown in Table 1. The graph in Fig. 1 depicts the effect of temperature on the viscosity of Baysilone Fluids P. This effect is greater than for Baysilone Fluids M but lower than for mineral oils.

Fluids of higher viscosity can be manufactured by special agreement. Intermediate viscosities within the range of Baysilone Fluids P can be obtained by blending different grades with one another. The required mixing ratio can be determined by using the diagram in Fig. 2. The lower viscosity should be marked on the left ordinate and the higher on the right and the two values connected by a straight line. The intersection of the connecting line with the abscissa parallel drawn through the desired viscosity value gives the required mixing ratio on the abscissa. Fig. 2 shows as an example how to obtain a viscosity of 500 $m^2 \cdot s^{-1}$ (cSt) by blending together Baysilone Fluids PN 200 and PN 1000. It is best to mix two of the same type of grades together.

Baysilone Fluids M (polydimethyl siloxanes) **should not be mixed** with Baysilone Fluids P, they are only soluble with one another within a very narrow range.

Weight Loss, Pour Point, Boiling Point, Vapour Pressure, Flash Point, Fire Point

It is important to note the differences between the various Baysilone Fluids P with respect to these properties. The high-polymeric PN and PH grades do not have a boiling point at all at atmospheric pressure and therefore have high flash and fire points. The vapour pressure of the PN and PH grades is so low that only very slight weight losses are observed in the Noack Test (Table 2).

Loss on evaporation is naturally much less at high temperatures at atmospheric pressure. Owing to this and their high long-term thermal stability, the PN and PH grades more than meet the demands made of heat transfer media (Table 3).

As a result of its low-polymeric structure, the PD 5 grade is a distillable liquid with a high boiling point and a low pour point, which makes the Noack Test superfluous. It is highly suitable as a low-viscosity damping and heat transfer fluid, low-temperature oil and as an auxiliary in the formulation of low temperature greases. Its flash and fire points are correspondingly lower than those of the PN and PH grades (Table 4).

Ignition points are higher, for example 370°C for PD 5 and 425°C for PN 200. Measurements were carried out according to DIN regulations.

Baysilone Fluid P	%-weight loss of a 65g sample after 1h at 25°C at 20mbar less than atmospheric pressure
PN 200	less than 1.0
PN 1000	less than 0.5
PH 300	less than 2.5
PH 1000	less than 1.5

Table 2: Noack Test.

Baysilone Fluid P	Vapour pressure in mbar at		
	25°C	100°C	150°C
PD 5	10^{-2}	4	34
PN 200	$\sim 10^{-6}$	$\sim 10^{-5}$	$\sim 10^{-4}$
PH 1000	$\sim 10^{-6}$	$\sim 10^{-5}$	$\sim 10^{-4}$

Table 3: Vapour pressure.

Baysilone Fluid P	Pour Point °C	Boiling Point °C at 1mbar	Flash Point °C	Fire Point °C
PN 200	~ -65	-	~ 300	~ 360
PN 1000	~ -55	-	~ 300	~ 360
PH 300	~ -40	-	~ 300	~ 360
PH 1000	~ -30	-	~ 300	~ 360
PD 5	~ -102	~ 105	~ 110	~ 150
PK 20	~ -70	~ 175	~ 140	~ 200

Table 4: Pour point, boiling point, flash point and fire point.

Thermal stability

is the area where Baysilone* Fluids P stand out. Their heat resistance is several times that of Baysilone Fluids M, which is why Baysilone Fluids P are particularly suitable for applications at high temperatures. The PN and PH grades can be exposed to continuous temperatures of 250°C in open containers for several hundred hours without decomposing. Although such extreme conditions may cause the fluids to turn yellow, this does not impair the products effectiveness.

In closed systems or in an inert atmosphere, the fluids can withstand temperatures of 250–300°C for several months and short term temperatures of over 300°C. In closed systems Baysilone Fluid PD 5, for example, can even survive temperatures of 400°C for several months at 12 bar vapour pressure without decomposing.

Provided vessels are made of standard materials such as glass, enamel, iron, stainless steel and brass, heat has little impact.

Baysilone Fluid P	PN 200	PN 1000	PH 300	PH 1000
Weight loss in % after 100 hours	10 - 12	9 - 10	19 - 22	15 - 20
Weight loss in % after gel time	35 - 40	12 - 19	54 - 60	44 - 49
Gel time in hours	1200 - 2200	300 - 500	1000 - 1500	1500 - 2000
Gel time in days	50 - 92	12 - 21	42 - 62	62 - 83

Table 5: Gel time and weight loss of Baysilone Fluids P after continuous exposure to 250°C (measured on 3g samples in crystallizing dishes with a diameter of 35 mm in an electric oven with air intake). Under the conditions of this test, a methyl silicone fluid such as Baysilone Fluid M 350 gels after less than 10 hours, thereby losing between 7 and 10% in weight.

Baysilone Fluid P		PN 200	PH 1000
Viscosity in mm^2s^{-1} (cSt) at 25 °C	before	195	970
	after	480	3308
Weight loss in %		10.2	11.1

Table 6: Viscosity and weight loss of Baysilone Fluids P after 350 hours continuous exposure at 250°C (measured on 75-g samples in 100-ml beakers in an electric oven with air intake).

Thermal conductivity, specific heat

The thermal conductivity of Baysilone Fluids P is in the usual range, as the coefficients of thermal conductivity indicate:

PD 5	$0.093\ W \cdot K^{-1} \cdot m^{-1}$
PH 300	$0.124\ W \cdot K^{-1} \cdot m^{-1}$
PH 1000	$0.131\ W \cdot K^{-1} \cdot m^{-1}$
PN 200	$0.131\ W \cdot K^{-1} \cdot m^{-1}$
PN 1000	$0.147\ W \cdot K^{-1} \cdot m^{-1}$

There are no appreciable differences between the specific heat values of the individual Baysilone Fluids P.

PD 5	at 25°C	$1.68\ J \cdot g^{-1} \cdot K^{-1}$
PN 200		$1.56\ J \cdot g^{-1} \cdot K^{-1}$
PD 5	at 100°C	$1.73\ J \cdot g^{-1} \cdot K^{-1}$
PN 200		$1.60\ J \cdot g^{-1} \cdot K^{-1}$
PD 5	at 200°C	$1.82\ J \cdot g^{-1} \cdot K^{-1}$
PN 200		$1.67\ J \cdot g^{-1} \cdot K^{-1}$

Radiation resistance

Unlike Baysilone Fluids M, Baysilone Fluids P are highly radiation-resistant. Tests with β rays have shown that a radiation dose of up to 2 $MJ \cdot kg^{-1}$ does not cause any gel formation in the case of Baysilone Fluids. PN and PH. The only effect is an increase in viscosity, coupled with a yellowing.

Density, Specific Volume, Coefficient of Expansion

The densities of Baysilone Fluids P at room temperature do not greatly differ from that of water. The PN and PH grades have densities of more than 1 and the low-viscosity grades PD and PK of less than 1. The effect of temperature on density is approximately linear, with the following mean cubic coefficients of expansion being determined in the range +25°C to +180°C:

Baysilone Fluid PN 200	$87 \cdot 10^{-5} \cdot K^{-1}$
Baysilone Fluid PN 1000	$83 \cdot 10^{-5} \cdot K^{-1}$
Baysilone Fluid PH 300	$82 \cdot 10^{-5} \cdot K^{-1}$
Baysilone Fluid PH 1000	$78 \cdot 10^{-5} \cdot K^{-1}$
Baysilone Fluid PD 5	$113 \cdot 10^{-5} \cdot K^{-1}$
Baysilone Fluid PK 20	$96 \cdot 10^{-5} \cdot K^{-1}$

To ensure a reliable calculation of the volume (V) of a given quantity of fluid (m) at a given temperature (t), it is recommended to start from the specific volume V_{spec}, the reciprocal value of density. In this respect, the value for the intended service temperature (V_{spec}(t)) is taken from Table 8 (below) or from the specific volumes plotted against various temperatures in Fig. 3.

The volume V_t of the employed quantity of fluid (m) required at this temperature is calculated according to the formula:

$$V_t = m \cdot V_{spec}(t)$$

Baysilone Fluid P	Density ($g \cdot cm^{-3}$) at					
	± 0°C	+25°C	+60°C	+100°C	+140°C	+180°C
PN 200	1.05	1.03	1.00	0.97	0.94	0.91
PN 1000	1.06	1.04	1.01	0.98	0.95	0.92
PH 300	1.08	1.06	1.03	1.00	0.97	0.94
PH 1000	1.10	1.08	1.06	1.03	1.00	0.97
PD 5	0.94	0.92	0.89	0.85	0.82	0.78
PK 20	1.00	0.98	0.96	0.92	0.89	0.86

Table 7: Effect of temperature on the density.

Baysilone Fluid P	Specific Volume ($V_{spec}=g \cdot cm^{-3}$) of Baysilone Fluid P				
	± 0°C	+25°C	+60°C	+100°C	+140°C
PN 200	0.97	1.00	1.03	1.06	1.10
PN 1000	0.96	0.99	1.02	1.05	1.09
PH 300	0.94	0.97	1.00	1.03	1.06
PH 1000	0.93	0.94	0.97	1.00	1.03
PD 5	1.09	1.12	1.18	1.22	1.28
PK 20	1.02	1.04	1.09	1.12	1.16

Table 8: Effect of temperature on the specific volume.

Compressibility

The densities of Baysilone* Fluids P at of Baysilone Fluids P is somewhat lower than that of Baysilone Fluids M. The adiabatic compressibility coefficients K_{ad} at 25°C are as follows:

Baysilone Fluid PD 5	$93 \cdot 10^{-11} \cdot m^2 \cdot N^{-1}$
Baysilone Fluid PN 200	$73 \cdot 10^{-11} \cdot m^2 \cdot N^{-1}$
Baysilone Fluid PH 300	$61 \cdot 10^{-11} \cdot m^2 \cdot N^{-1}$

The Surface Tension

of Baysilone Fluids P is only slightly dependent on viscosity. It is slightly higher than that of Baysilone Fluids M:

Baysilone Fluid PD 5	$24.2\ mN \cdot m^{-1}$
Baysilone Fluid PN 200	$23.1\ mN \cdot m^{-1}$
Baysilone Fluid PH 300	$22.2\ mN \cdot m^{-1}$

The Refractive Index

of Baysilone Fluids P is little affected by viscosity. It rises in relation to the content of phenyl groups:

Baysilone Fluid PD 5	n_D^{25} 1.438
Baysilone Fluid PN 200	n_D^{25} 1.466
Baysilone Fluid PH 300	n_D^{25} 1.512

As a comparison, the refractive index of Baysilone Fluid M 350 is 1.4036.

Dielectric Performance

The dielectric strength of all Baysilone Fluids P ranges between 22 and 30 $kV \cdot mm^{-1}$t 25°C and 50% relative humidity.

Dissipation factor tan δ	at 25°C	at 150°C
Baysilone Fluid PD 5	0.0005	0.0340
Baysilone Fluid PN 200	0.0001	0.0034
Baysilone Fluid PH 300	0.0015	0.0160

The dielectric constant of Baysilone Fluids P is between 2.5 and 3.0 for temperatures between 25 and 150°C. The differences are greater in the case of other electrical and dielectric properties:

Volume resistivity ρ_D in $\Omega \cdot cm$		
Baysilone Fluid PD 5	$3 \cdot 10^{13}$	$3 \cdot 10^{12}$
Baysilone Fluid PN 200	$4 \cdot 10^{14}$	$5 \cdot 10^{12}$
Baysilone Fluid PH 300	$8 \cdot 10^{12}$	$7 \cdot 10^{11}$

Figures 4, 5 and 6 show the effect of temperature on electric and dielectric values.

Lubricating Properties

Baysilone* Fluids P have better lubricating properties than Baysilone Fluids M. Since the PN and PH grades also have very good compatibility with metal soaps and other additives used in grease production, they are ideal for the formulation of heat-resistant lubricating greases, especially as they have long-term thermal stability. The PD grade has the same compatibility and can therefore be used as a low-temperature oil or as an auxiliary in the formulation of low-temperature greases.

Solubility

Baysilone Fluids P have good solubility in a large number of organic solvents. Particularly suitable are aliphatic and aromatic hydrocarbons and their halogen derivatives, alcohols, linear and cyclic ethers, ketones and esters such as:

- petroleum spirit
- benzene
- toluene
- chloroform
- carbon tetrachloride
- trichloroethylene
- ethyl alcohol
- butyl alcohol
- amyl alcohol
- diethyl ether
- dioxane
- tetrahydrofuran
- acetone
- cyclohexanone
- dimethylformamide

In contrast to Baysilone Fluids M, Baysilone Fluids P are also soluble in lower alcohols from ethyl alcohol upwards. The fluid PD 5 is even soluble in methyl alcohol.

All Baysilone Fluids P are insoluble in water, although fluids PD 5 and PK 20 are partially soluble in aqueous alcohols such as:

solvent	PD 5	PK 20
80% ethyl alcohol	3%	0.4%
80% isopropylene alcohol	10%	0.6%

The Neutralisation Value

of Baysilone Fluids P is less than 0.04. This means that 1g fluid requires less than 0.04 mg potassium hydroxide to neutralise the acid constituents.

Chemical stability and storage stability

Baysilone Fluids P, in particular the PD grade, are generally inert and are only attacked by aggressive substances such as concentrated mineral acids, free halogens, anhydrous hydrogen halides and superheated steam. Diluted mineral acids and alkalis have little effect.

Table 9 gives the percentage change in viscosity after 12 hours exposure to a variety of acids and alkalis at 25°C and 100°C.

The grades are resistant to water, organic solvents and plastics. Contact with most metals causes no change. Even prolonged exposure does not cause any precipitation of solids or any change in colour, odour or acid value. Because Baysilone Fluids P are not miscible with water, improper storage resulting in contact with water may cause turbidity. Climatic changes have no influence on the storage stability of Baysilone Fluids P. The combustion of Baysilone Fluids P leads to the generation of silicon dioxide, carbon dioxide and water.

% change in viscosity	PD 5		PN 200		PH 300	
after 12 hours	25°C	100°C	25°C	100°C	25°C	100°C
1 n sodium hydroxide solution	±0	+1.9	+6.7	+5.6	±0	+11.4
1 n hydrochloric acid	+1.9	+1.9	+2.8	+4.8	+0.7	+1.9
37% hydrochloric acid	+1.9	-0.4	+16.3	+24.2	+32.7	+17.3
13% nitric acid	+1.2	+1.2	+4.5	+5.6	+0.8	+1.0
30% sulphuric acid	+1.5	+1.2	+3.4	+6.7	+0.7	+1.7

Table 9: Chemical stability, percentage of change in viscosity after 12 hours exposure to a variety of acids and alkalis at 25°C and 100°C.

Physical Form and physiological Behaviour

Baysilone Fluids P are clear, water-white fluids which have no noticeable odour or taste. Like Baysilone Fluids M, Baysilone Fluids P are not toxic under the terms of the EU classification. If they get into the eye, they may, like other foreign substances, cause a temporary irritation of the conjunctiva. Because of their inertness to the human skin and their ability to form protective films against water and aqueous solutions, special grades in the PD and PK range are valuable raw materials in dermatology and cosmetics.

Figures

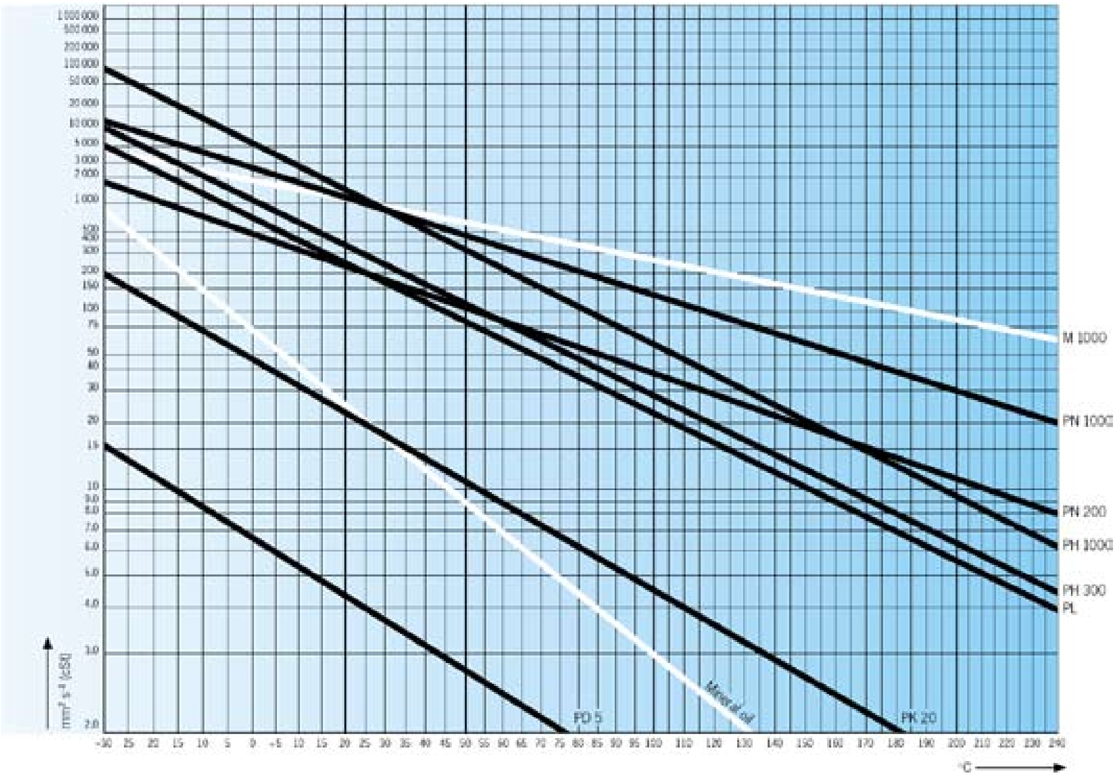

Figure. 1: The effect of temperature on the viscosity of Baysilone* Fluids P as compared to mineral oil and Baysilone Fluid M 1000.

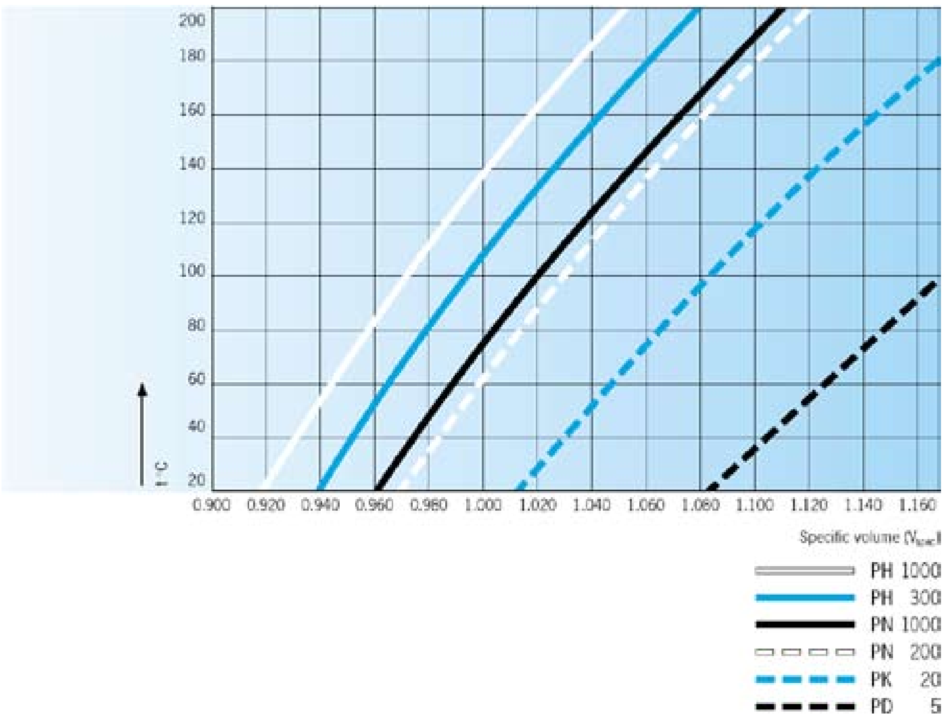

Figure. 2: Effect of temperature on the specific volume of Baysilone* Fluids P.


250 m

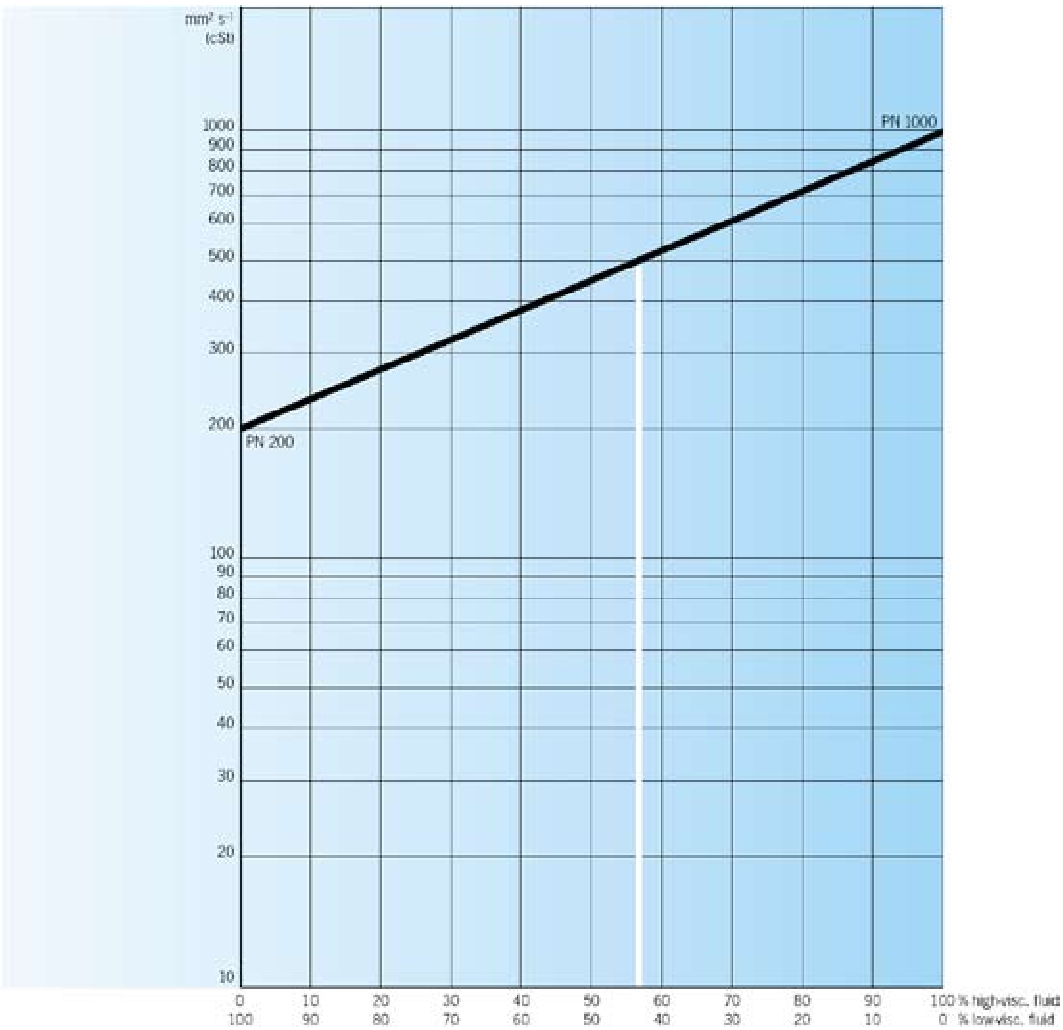

Figure. 3: Adjustment of the viscosity of Baysilone* Fluids P by blending straight line. The intersection of the connecting line with the abscissa parallel drawn through the desired viscosity value gives the required mixing ratio on the abscissa. Fig. 2 shows as an example how to obtain a viscosity of 500 m2·s–1 (cSt) by blending together Baysilone Fluids PN 200 and PN 1000. It is best to mix two of the same type of grades together.
Baysilone Fluids M (polydimethyl siloxanes) should not be mixed with Baysilone Fluids P (polymethylphenyl siloxanes) because they are only soluble with one another within a very narrow range.

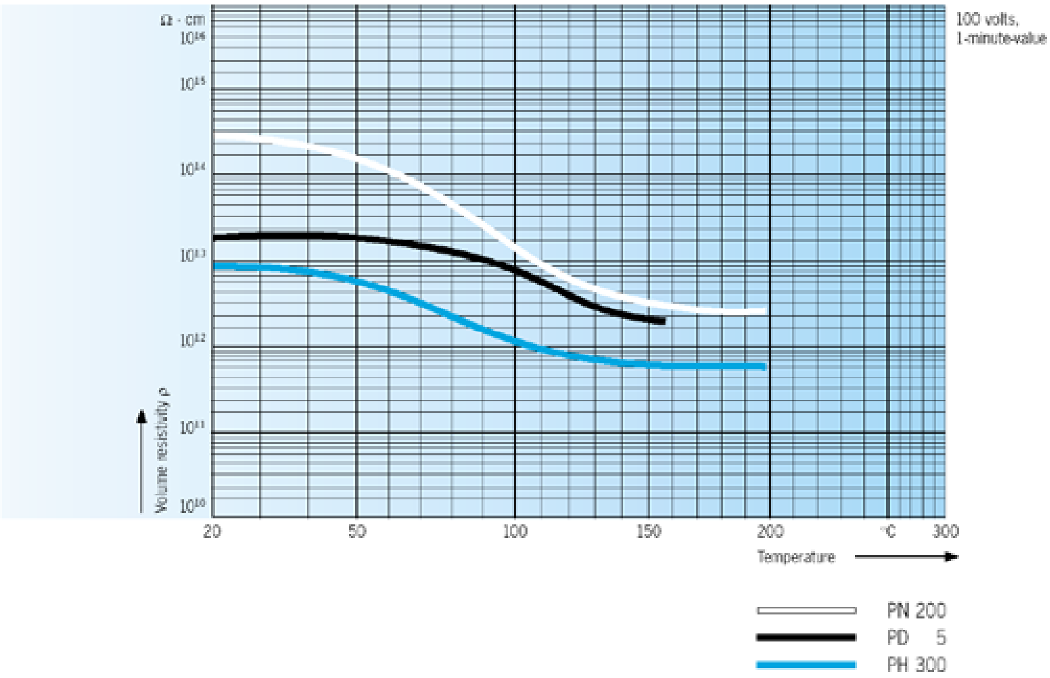

Figure. 4: Effect of temperature on the volume resistivity of Baysilone Fluids P.

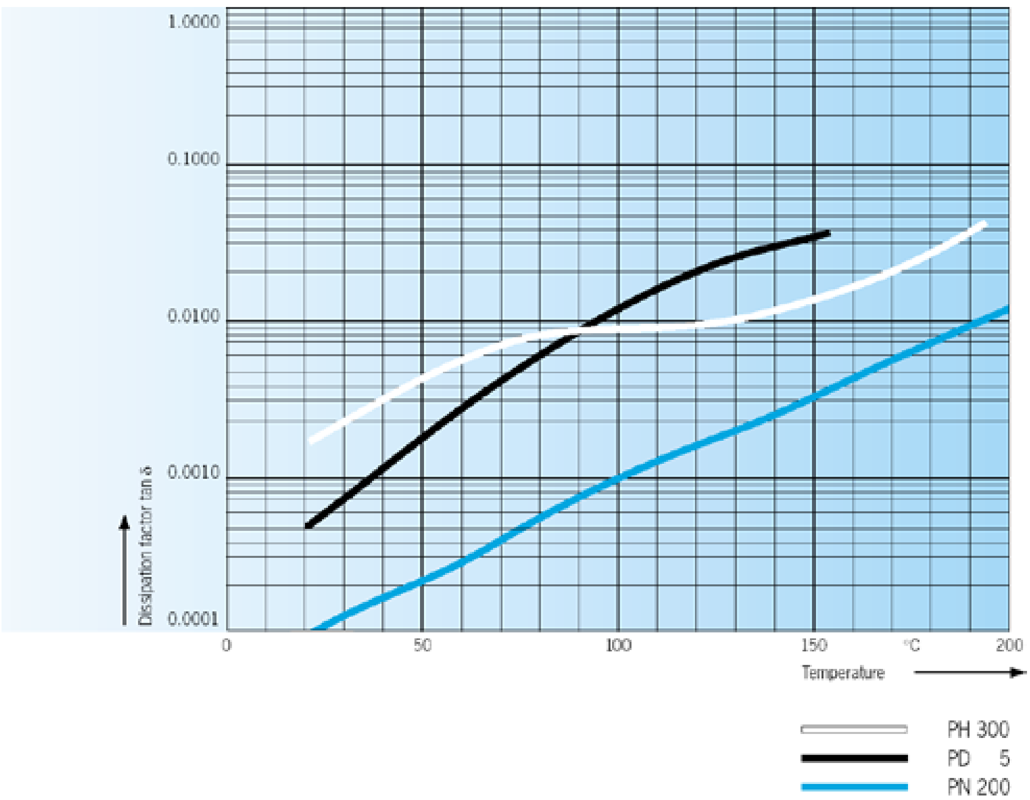

Figure. 5: Effect of temperature on the dissipation factor tan δ of Baysilone Fluids P.

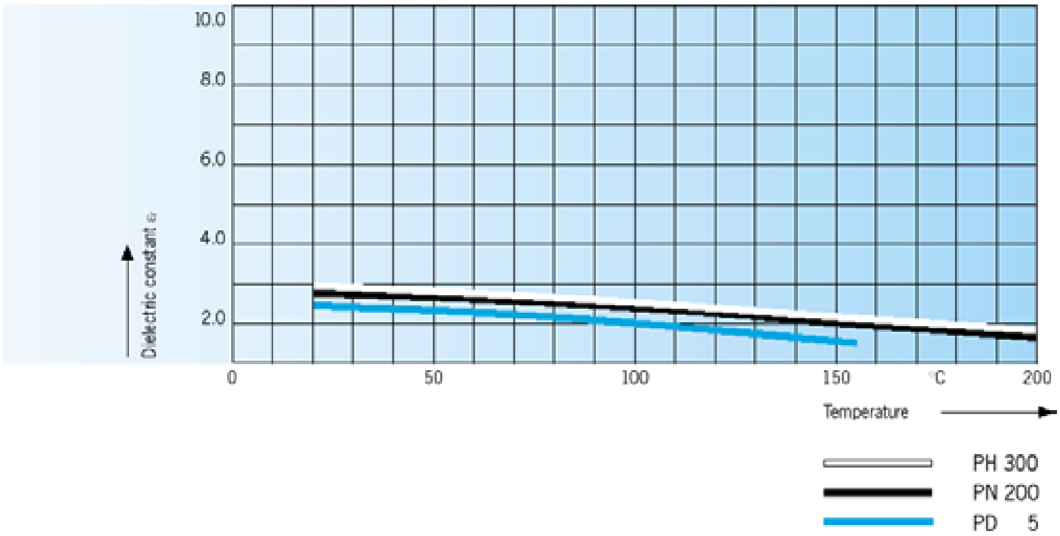

Figure. 6: Effect of temperature on the dielectric constant εr of Baysilone Fluids P.

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The science behind the solutions.

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