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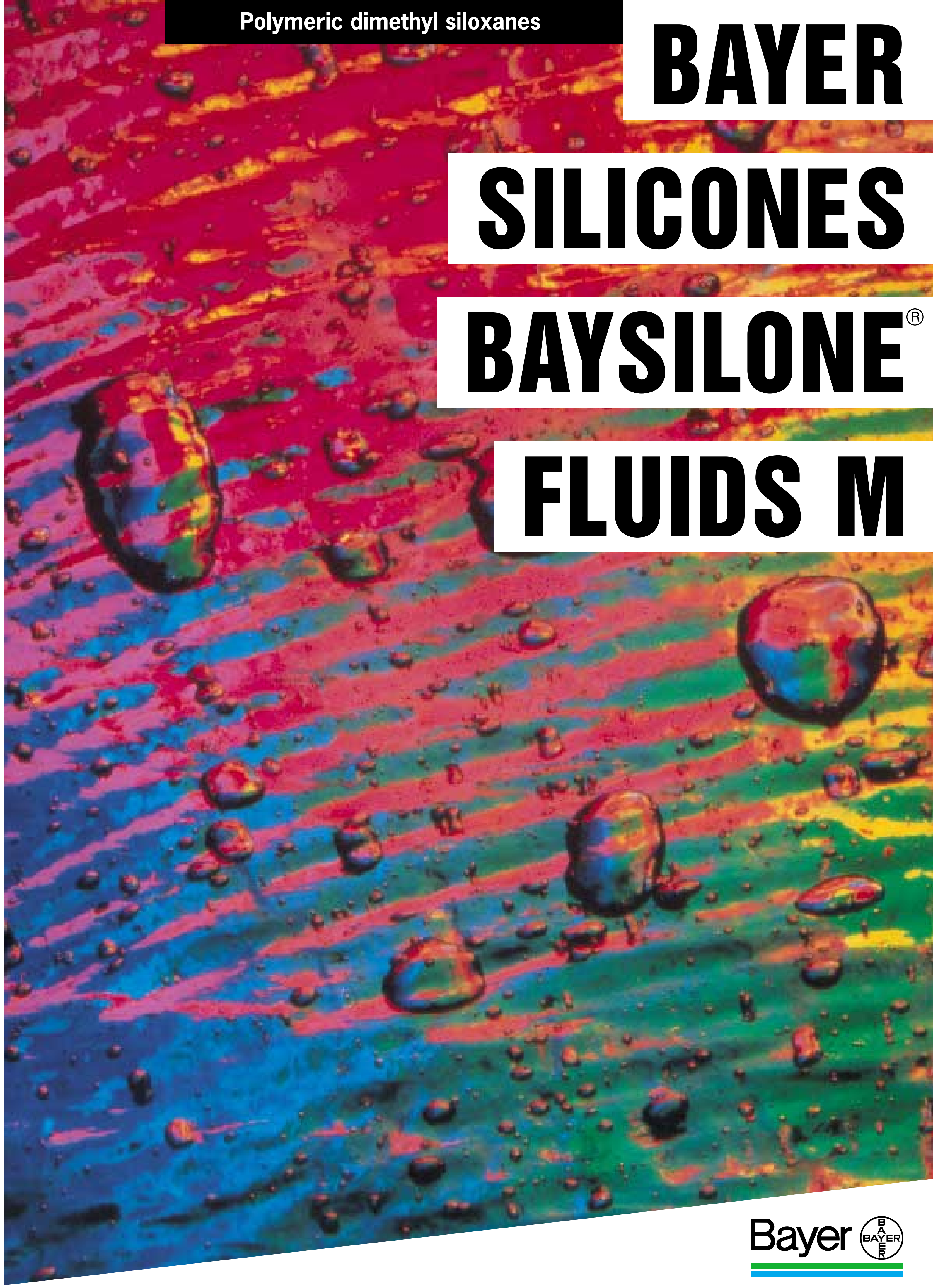

Polymeric dimethyl siloxanes

BAYER SILICONES BAYSILONE® FLUIDS M

Bayer

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Contents	Page

Baysilone® Fluids M are a group of liquid, water-clear polydimethyl siloxanes. They differ from organic compounds in both their physical and chemical properties which, singly or in combination, have won Baysilone Fluids a special place in technological applications. These properties are:

- High and low-temperature stability
- A low pour point
- Minimum effect of temperature and pressure on viscosity
- Low vapour pressure
- Favourable dielectric characteristics little influenced by temperature and frequency
- High interfacial tension to water and organic polymers
- High surface activity
- High compressibility
- Chemical and physiological inertness

As a result of these properties, Baysilone Fluids M are eminently suitable for use as

- Heat transfer media
- Hydraulic fluids
- Liquid dielectrics
- Water repellents
- Polishes
- Mould release agents
- Lubricants
- Antifoams
- Damping fluids
- Auxiliaries for the manufacture of cosmetics and pharmaceuticals

The range of Baysilone Fluids M comprises various grades which differ in their viscosity and in related properties. The adjacent list constitutes a survey of the entire range of Baysilone Fluids M.

In addition to the grades listed here, Baysilone Fluids are available, if required, in other viscosities, provided that large or regular supplies are involved. Low-viscosity Baysilone Fluids M are available down to a minimum viscosity of 0.7mm² · s⁻¹ (cSt). Please ask for further information in individual cases.

Baysilone® Fluid M [1]	Viscosity tolerance ± %	Viscosity class
3	10	low-viscosity
5	10	
10	10	
20	10	
50	10	medium-viscosity
100	5	
350	5	
500	5	
1 000	5	
1 500	5	
5 000	5	high-viscosity
10 000	5	
12 500	5	
30 000	5	
60 000	5	
100 000	5	
300 000	10	
500 000	10	ultrahigh-viscosity
1 000 000	10	
2 000 000	10	

[1] The values correspond to the nominal viscosity in $mm^2 \cdot s^{-1}$ at 25°C (DIN 53 019).

Intermediate values are obtained by blending in accordance with the blending chart shown on p. 14 (Fig. 1). More detailed information on blending techniques and the use of the chart are to be found on p. 9 of this pamphlet. Temperature has very little effect on the viscosity of Baysilone Fluids M. The graph in Fig. 2 (p. 15) shows the effect of temperature on Baysilone Fluids M as compared with mineral oils of similar viscosity.

Viscosity: The effect of temperature

Baysilone® Fluid M	Viscosity in $mm^2 \cdot s^{-1}$ (cSt) at											
	–80 °C	–60 °C	–40 °C	–20 °C	0 °C	25 °C	40 °C	60 °C	80 °C	100 °C	120 °C	140 °C
3	70	28	13	7	4.6	3	2.4	1.8	1.5			
5	132	50	23	14	7.8	5	4.0	3.1	2.6	2.2		
10		120	52	27	16	10	7.9	6.0	4.9	4.0	3.1	2.7
20		270	100	57	34	20	15.2	11.8	9.2	7.2	6.0	5.0
50				150	85	50	40	28	20	16	13	10
100				290	170	100	75	55	41	32	27	21
350				1 000	620	350	290	200	150	125	95	75
500				1 300	850	500	400	290	210	165	140	110
1 000				2 900	1 850	1 000	750	520	400	300	230	190
5 000					8 500	5 000	3 800	2 800	2 000	1 600	1 200	1 000
12 500					20 000	12 500	9 800	7 000	5 100	4 000	3 000	2 400
30 000					50 000	30 000	22 000	16 500	11 500	8 500	7 000	5 000
60 000					100 000	60 000	42 000	30 000	20 000	15 500	11 000	9 000
100 000					180 000	100 000	75 000	55 000	40 000	30 000	22 000	17 000
300 000					500 000	300 000	200 000	175 000	133 000	100 000	78 000	62 000
1 000 000					2 000 000	1 000 000	750 000	520 000	390 000	280 000	210 000	160 000

The effect of pressure

The viscosity of Baysilone Fluids M, unlike that of mineral oils, is scarcely affected by pressure. A pressure of 2,000 bar at 25°C causes the viscosity of mineral oil to increase 50 to 5,000 times, depending on the grade, whereas the viscosity of Baysilone Fluid M 1000, for example, increases only 14 times under the same conditions. Even when subjected to extreme pressures, at which mineral oils solidify, Baysilone Fluids M remain liquid.

Fig. 3 (p. 16) shows the viscosity of Baysilone Fluid M 100 and M 1000 in graph form at different temperatures as a function of pressure.

Shear behaviour

Baysilone Fluids M act as Newtonian fluids at viscosities below 1000 $mm^2 \cdot s^{-1}$ up to a shear rate of over $5 \cdot 10^3$ s^{-1}. At higher viscosities the pseudoplasticity is noticeable even at low shear rates. If the temperature of a fluid is increased, the range of Newtonian behaviour shifts to higher shear rates.

Fig. 4 (p. 17) shows the viscosity of Baysilone Fluids M as a function of the shear rate.

Pour points, flash points, fire points, ignition points

Baysilone® Fluid M	Pour point °C below DIN 51597	Flash point °C above DIN 51376	Fire point °C above DIN 51376
3	approx. –100	approx. 62	approx. 110
5	approx. –100	approx. 120	approx. 160
10	approx. – 90	approx. 170	approx. 230
20	approx. – 70	approx. 240	approx. 290
50	approx. – 60	approx. 280	approx. 350
*50 EL	approx. – 60	approx. 300	approx. 350
100	approx. – 50	approx. 300	approx. 370
350	approx. – 50	approx. 315	approx. 380
500	approx. – 50	approx. 315	approx. 380
1 000	approx. – 50	approx. 320	approx. 390
5 000	approx. – 50	approx. 320	approx. 390
12 500	approx. – 50	approx. 320	approx. 390
30 000	approx. – 50	approx. 320	approx. 390
60 000	approx. – 50	approx. 320	approx. 390
100 000	approx. – 50	approx. 320	approx. 400
300 000	approx. – 40	approx. 320	approx. 400
1 000 000	approx. – 40	approx. 320	approx. 400

*= dielectric cooling agent for transformers; see "Baysilone M 50 EL" brochure

The ignition temperatures of Baysilone Fluids M are above 400°C. They therefore belong to ignition group G 2.

Baysilone Fluids M are characterised by the fact that they retain their liquid state over an unusually wide range of temperatures. The pour point of certain types of Baysilone Fluids M is below –100°C. Because of the high molecular weight structure, the boiling points cannot be determined at all at atmospheric pressure. The pour, flash and fire points become higher as the viscosity of Baysilone Fluids M increases.

Vapour pressure

The vapour pressure of medium and high-viscosity Baysilone Fluids M is very low. At temperatures between 25°C and 175°C, it is between 10^{-5} and 10^{-4} mbar. Only the low-viscosity grades possess a noticeably higher vapour pressure. The flash point can be taken as an indication of this.

In order to determine the volatile constituents of Baysilone Fluids M at 250°C, the **Noack Test** (heating a 65 g sample for one hour at atmospheric pressure reduced by 20 mbar and at 250°C) was used. The weight losses which occurred were as follows:

Noack Test for Baysilone® Fluids M at 250°C (as per DIN 51581)		Weight loss %
Baysilone Fluid M	50	less than 5.0
	100	less than 3.0
	350	less than 1.0
	500	less than 1.0
	1 000	less than 1.0
	> 5 000	less than 0.3

Density

Baysilone® Fluid M	Density in g · cm⁻³					
	–40°C	0°C	25°C	50°C	100°C	175°C
3	0.97	0.93	0.90	0.88		
5	0.99	0.95	0.92	0.90		
10	1.02	0.97	0.94	0.92		
20	1.02	0.98	0.95	0.93		
50	1.03	0.99	0.96	0.94	0.90	0.84
100	1.04	1.00	0.97	0.95	0.91	0.85
350	1.04	1.00	0.97	0.95	0.91	0.85
500	1.04	1.00	0.97	0.95	0.91	0.85
1 000	1.04	1.00	0.97	0.95	0.91	0.85
5 000	1.04	1.00	0.97	0.95	0.91	0.85
12 500	1.04	1.00	0.97	0.95	0.91	0.85
30 000			0.97	0.95	0.91	0.85
60 000			0.97	0.95	0.91	0.85
100 000			0.97	0.95	0.91	0.85
300 000			0.97	0.95	0.91	0.85
1 000 000			0.97	0.95	0.91	0.85

The densities of Baysilone Fluids M at 25°C are between 0.90 and 0.97. In other words they do not greatly differ from that of water. The density of the fluids increases with viscosity. The effect of temperature on density is approximately linear. Measurement of the density between –40°C and 175°C produced the figures shown in the table above.

Thermal stability

In the presence of air, Baysilone Fluids M have practically unlimited stability at temperatures of up to 150°C. The fluids will also stand up well to higher temperatures if the access of air is restricted, e. g. by reducing the exposed surface of the fluid or by sealing off the fluid completely using a narrow pressure-equalising connection pipe. Where air is totally excluded by using the fluids in completely enclosed systems or in an inert atsmosphere, e. g. under a nitrogen or carbon dioxide cushion, the fluids may even be exposed to temperature peaks of approx. 300°C. In this case the viscosity gradually decreases, whereas it will gradually increase at elevated temperatures if the access of air is not impeded.

Thermal conductivity, thermal capacity, specific heat

The thermal conductivity of Baysilone Fluids M is not affected by temperature. Even the level of viscosity has only a slight effect. Thus, although the coefficient of thermal conductivity λ increases somewhat from the low to the medium-viscosity oils, it undergoes no further change when the high-viscosity grades are reached.

The following values for the coefficient of thermal conductivity λ were determined at both 25°C and 250°C.

Baysilone® Fluid M	W · K⁻¹ · m⁻¹
3	0.105
5	0.116
10	0.140
20	0.140
100	0.163
1 000	0.174
12 500	0.174
100 000	0.174

When determining the mean specific heat c of Baysilone Fluids M 50 to M 12500, there were no appreciable differences between the individual fluids; the same holds true for the thermal capacity W_{20}. The relationship between the values obtained is shown in the table below.

t in °C	c in $J \cdot g^{-1} \cdot K^{-1}$	W_{20} in $J \cdot g^{-1}$
20	1.51	0
40	1.51	30.6
60	1.55	62.0
80	1.55	93.4
100	1.55	123.5
120	1.59	157.8
140	1.59	192.2
160	1.63	229.0
180	1.67	267.5
200	1.73	309.0

Coefficient of expansion, specific volume

The mean cubic expansion coefficient γ of Baysilone Fluids M in the range 25°C to 175°C is between 99 and $111 \cdot 10^{-5} \cdot K^{-1}$. The differences are slight among the individual types of fluids; a slight increase in the coefficients of expansion is only observed towards the lower viscosities.
The volume V_t, taken up by a given quantity of fluid m at a temperature t, can be calculated by means of the equation

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

The specific volume $V_{spec.}$ (t) of Baysilone Fluids M is given below for certain temperatures. Fig. 5 (p. 18) shows the volume of Baysilone Fluids M as a function of temperature.

Baysilone® Fluid M	Mean cubic expansion coefficient $10^{-5} \cdot K^{-1}$	Specific volume in $cm^3 \cdot g^{-1}$ at					
		−40°C	0°C	25°C	50°C	100°C	175°C
3	111	1.03	1.08	1.11	1.14		
5	108	1.01	1.05	1.09	1.11		
10	103	0.98	1.03	1.06	1.09		
20	101	0.98	1.02	1.05	1.08		
50	100	0.97	1.01	1.04	1.06	1.11	1.19
100	99	0.96	1.00	1.03	1.05	1.10	1.18
350	99	0.96	1.00	1.03	1.05	1.10	1.18
500	99	0.96	1.00	1.03	1.05	1.10	1.18
1 000	99	0.96	1.00	1.03	1.05	1.10	1.18
5 000	99	0.96	1.00	1.03	1.03	1.10	1.18
12 500	99	0.96	1.00	1.03	1.03	1.10	1.18
30 000	99			1.03	1.03	1.10	1.18
60 000	99			1.03	1.03	1.10	1.18
100 000	99			1.03	1.03	1.10	1.18
300 000	99			1.03	1.03	1.10	1.18
1 000 000	99			1.03	1.03	1.10	1.18

Compressibility

The volume of Baysilone Fluid M 1000 decreases by 15% under a pressure of 3,500 bar, and by about 30% under a pressure of 25,000 bar. The low-viscosity fluids have even higher compressibility. As can be seen from the values given below, the compressibility is relatively high; Baysilone Fluids M are therefore suitable for use in fluid spring systems.

Baysilone® Fluid M	Adiabatic compressibility K_{ad} in $m^2 \cdot N^{-1}$ measured at 25°C
50	$101.6 \cdot 10^{-11}$
100	$100.8 \cdot 10^{-11}$
350	$100.0 \cdot 10^{-11}$
500	$99.8 \cdot 10^{-11}$
1 000	$99.8 \cdot 10^{-11}$

Surface tension

The surface tension of Baysilone Fluids M is about 19–21mN $\cdot m^{-1}$, and is thus extremely low. It shows a very slight increase from the low-viscosity to the high-viscosity fluids.

Refractive index

The refractive index of Baysilone Fluids M rises from n_{25}^{D} = 1.3941 for M 3 through 1.4000 for M 20 until it reaches a virtually constant value of 1.4042 for M 1000 and above.

Dielectric performance

Because of their satisfactory dielectric characteristics, Baysilone Fluids M are useful dielectrics. Measurements have revealed that the dielectric strength, volume resistivity, dielectric constant and dissipation factor are little affected by temperatures over a wide range. Similarly, there is very little change in the dielectric constant and the dissipation factor over a frequency range from 10^2 to 10^7 Hertz. The relevant data for Baysilone Fluid M 350 can be seen in Figs. 6 and 7 (p. 19 and p. 20). The dielectric characteristics of other Baysilone Fluids M are listed in the following table and are also contained in the “Baysilone M 50 EL” brochure.

Baysilone® Fluid M	Temp. °C	Dielectric constant ε_r as per DIN 53 483		Dissipation factor tan δ as per DIN 53 483		Volume resistivity ρ_D in $\Omega \cdot cm$ as per DIN 53 482 measured at 100 V for 1 min
		50 Hz	800 Hz	50 Hz	800 Hz	
3	−50	3	2.9	$1 \cdot 10^{-4}$	$7.8 \cdot 10^{-5}$	$6 \cdot 10^{15}$
	0	2.8	2.6	$2 \cdot 10^{-4}$	$1.8 \cdot 10^{-4}$	$4 \cdot 10^{14}$
	100	2.4	2.3	$1.5 \cdot 10^{-3}$	$2.3 \cdot 10^{-4}$	$1 \cdot 10^{13}$
	200	2.1	2.1	$5.5 \cdot 10^{-3}$	$3.6 \cdot 10^{-4}$	$7 \cdot 10^{12}$
20	−50	3	3	$8.4 \cdot 10^{-5}$	$6.5 \cdot 10^{-5}$	$4 \cdot 10^{16}$
	0	2.9	2.8	$8.0 \cdot 10^{-5}$	$6.8 \cdot 10^{-5}$	$4 \cdot 10^{15}$
	100	2.4	2.4	$9.0 \cdot 10^{-5}$	$9.0 \cdot 10^{-5}$	$3 \cdot 10^{14}$
	200	2.2	2.2	$3.5 \cdot 10^{-3}$	$5.5 \cdot 10^{-4}$	$2 \cdot 10^{13}$
50	−50	3.1	3	$1.2 \cdot 10^{-4}$	$6.5 \cdot 10^{-5}$	$8 \cdot 10^{15}$
	0	3	2.9	$1.2 \cdot 10^{-4}$	$7.2 \cdot 10^{-5}$	$6 \cdot 10^{14}$
	100	2.6	2.4	$1.7 \cdot 10^{-4}$	$1.2 \cdot 10^{-4}$	$6 \cdot 10^{13}$
	200	2.3	2.2	$1.2 \cdot 10^{-3}$	$4.2 \cdot 10^{-3}$	$3 \cdot 10^{13}$
100	−50	3.1	3	$7.0 \cdot 10^{-5}$	$7.0 \cdot 10^{-5}$	$2 \cdot 10^{16}$
	0	2.9	2.8	$7.0 \cdot 10^{-5}$	$7.0 \cdot 10^{-5}$	$1 \cdot 10^{15}$
	100	2.5	2.5	$6.2 \cdot 10^{-5}$	$7.5 \cdot 10^{-5}$	$1 \cdot 10^{14}$
	200	2.4	2.2	$9.0 \cdot 10^{-4}$	$1.8 \cdot 10^{-4}$	$4 \cdot 10^{13}$
60 000	−50	3.4	3.4	$7.0 \cdot 10^{-5}$	$8.0 \cdot 10^{-5}$	$2 \cdot 10^{16}$
	0	2.9	2.9	$6.6 \cdot 10^{-5}$	$7.0 \cdot 10^{-5}$	$1 \cdot 10^{15}$
	100	2.7	2.5	$6.5 \cdot 10^{-5}$	$7.9 \cdot 10^{-5}$	$5 \cdot 10^{13}$
	200	2.5	2.3	$6.8 \cdot 10^{-4}$	$1.4 \cdot 10^{-4}$	$2 \cdot 10^{13}$

Solubility

Satisfactory solvents for all Baysilone Fluids M are aliphatic and aromatic hydrocarbons, higher alcohols, ethers, esters and chlorinated hydrocarbons, e. g.

petroleum spirit	ethyl acetate
benzene	butyl acetate
toluene	carbon tetrachloride
ether	chloroform
butyl alcohol	trichloroethylene
amyl alcohol	acetylene tetrachloride

Baysilone Fluids are insoluble in water, methanol and ethylene glycol. Their solubility in organic solvents increases as their viscosity decreases. Baysilone Fluids M 50 and M 100 are thus also soluble in isopropanol and n-butanol and have limited miscibility with n-propanol. In addition to being soluble in n-propanol, Baysilone Fluids M with viscosities of less than 20 $mm^2 \cdot s^{-1}$ are soluble in acetone and dioxane. Baysilone Fluids M with viscosities down to 10 $mm^2 \cdot s^{-1}$ are also soluble in ethanol.

The solubility of gases in Baysilone Fluids M

Gases have a relatively high solubility in Baysilone Fluids M, and this is scarcely affected by temperature. The differences in solubility between the individual Baysilone Fluids M are also relatively small. At room temperature and normal atmospheric pressure, the following quantities of gas are soluble in 1 gram of fluid:

air	approx. 0.190 cm^3
nitrogen	approx. 0.170 cm^3
carbon dioxide	approx. 1.00 cm^3

Neutralisation value

The neutralisation value of Baysilone Fluids M is less than 0.01. Thus 1 g fluid requires less than 0.01 mg potassium hydroxide in order to neutralise the acid constituents.

Lubricating and slip properties

The following information on the lubricating properties of Baysilone Fluids M is intended primarily to serve as a reference for applications where Baysilone Fluids M are to be used as hydraulic fluids, heat transfer media and the like, and where their lubricating properties are valuable extra assets.

The lubricating properties of Baysilone Fluids M depend to a large extent on the particular bearing materials used. The best results are obtained with plastics, e.g. polyamides, polystyrene and phenolic resins, as well as with rubber. Baysilone Fluids M are also suitable as lubricants for certain combinations of metals, e.g. steel with bronze, brass, chrome and zinc, and chrome with bronze. They have no lubricating properties, however, in the case of steel/steel contact within the range of limit friction. It is therefore necessary to decide in each individual case whether the use of Baysilone Fluids M in a pure form is appropriate where there are lubricating problems.

In cases where Baysilone Fluids M are formulated with additions of thickening components to give greases, the lubricating properties are improved, since a part of the lubricating function is taken over by the additive.

The lubricating properties of the fluids must not be confused with their slip properties. Baysilone Fluids M constitute excellent slip agents in many applications, e.g. in the processing of certain plastics and synthetic fibres. In this function, the effectiveness of Baysilone Fluids M is attributable more to their release action than to the formation of a load-carrying lubricating film.

Chemical stability/ Compatibility with materials

Baysilone Fluids M are generally inert. They are resistant to water, organic solvents, pure oxygen and many chemicals. Contact with most metals causes no change and the fluids themselves attack neither metals nor wood, paper or plastics. The table below shows how Baysilone Fluids M are affected by a number of materials known for their aggressive nature. It gives the % change in viscosity after 12 hours' exposure at 25°C and 100°C respectively to a variety of acids and alkalis.

% change in viscosity after 12 hours	Baysilone® Fluid M 50		Baysilone Fluid M 100	
	25°C	100°C	25°C	100°C
1 n sodium hydroxide solution	+ 1.1	+ 1.0	+ 0.1	− 2.0
1 n hydrochloric acid	+ 2.2	− 0.6	+ 1.2	− 5.0
36% hydrochloric acid	+29.2	+30.5	+12.1	− 4.2
13% nitric acid	+ 7.6	+ 4.0	+ 3.8	−18.8
30% sulphuric acid	−	+ 5.8	−	+ 6.0

Strong oxidants, such as concentrated nitric acid and elementary chlorine, cause Baysilone Fluids M to deteriorate, especially at elevated temperature. An important point regarding the use of Baysilone Fluids M in electrical applications is that silicon dioxide is formed as the main combustion product when the fluids burn and that this, unlike graphitic carbon, is non-conductive.

Storage stability

Climatic changes have no influence on the properties of Baysilone Fluids M. When properly stored, they are stable for many years; they neither precipitate any solids, even after long periods of time, nor undergo any changes in colour or acid value. As a result of their extremely low vapour pressure, their low pour point and their absolute inertness to packaging materials, there are no special requirements with regard to storage vessels and conditions. As with any other oily fluid, contact with water generally results in emulsion turbidity.

Miscibility and viscosity adjustment

Baysilone Fluids M are freely miscible with one other. They are also miscible with the PD 5 and PK 20 grades of the P range of Baysilone Fluids, but not with the PN 200, PN 1000, PH 300 and PH 1000 grades of the same range.

In cases where silicone fluids with a viscosity differing from the grades described here are required, these can easily be obtained by blending. This of course only holds true for those viscosities which are within the range of the Baysilone Fluid grades. The requisite mixing proportions can be seen from the graph (Fig. 1). If, for example, it is desired to obtain a fluid with a viscosity of 6000 $mm^2 \cdot s^{-1}$ by blending Baysilone Fluid M 1000 (viscosity 1000 $mm^2 \cdot s^{-1}$) and grades M 12500 (viscosity 12,500 $mm^2 \cdot s^{-1}$) at 25°C, the value 1000 $mm^2 \cdot s^{-1}$ should be marked on the left and the value 12,500 $mm^2 \cdot s^{-1}$ on the right ordinate, and the tow values should be connected by a straight line. The intersection of the connecting line with the abscissa parallel, which is drawn through the ordinate value 6000 $mm^2 \cdot s^{-1}$, gives the blending proportions in per cent on the abscissa, namely 70% Baysilone Fluid M 12500 and 30% Baysilone Fluid M 1000.

Physiological behaviour

Baysilone Fluids M are water-clear liquids which have neither odour nor taste. They are non-toxic and physiologically inert. This was determined in various tests on the acute and chronic toxicity in animals and has been confirmed by many years of experience with the product. Because of their inertness to the human skin and their ability to form protective films against water and aqueous solutions, polydimethyl siloxanes are valuable raw materials in dermatology and cosmetics. If silicone fluids get into the eye, they may, like any other foreign substance, cause a temporary irritation of the conjunctiva, as a result of the hydrophobic effect of the silicone. This may temporarily reduce eye moisture. However, we do not know of any cases where contact has caused permanent damage.

Special commercial and processing formulations

Baysilone Fluids M are marketed by us in the range of grades listed here. Their wide variety of applications and the widely divergent requirements made by these, however, have induced us to offer the fluids as well as the emulsions, aerosols, release agents etc. made from them in special commercial and processing formulations. For each of these products we publish special instructions for use and processing.

Where special demands are made with respect to heat stability, processability to lubricating greases and solubility for given applications, Baysilone Fluids P, another product in the Baysilone Fluid range, can be used to best advantage. In this connection see the brochure on Baysilone Fluids P (AC 12 023).

Especially for the use as an heat transfer medium in open systems Baysilone Fluids M and P are available in stabilized grades. In respect of demand please contact us.

BAYER SILICONES BAYSILONE® FLUIDS MPH

Baysilone Fluids MPH is Bayer's proprietary name for polydimethyl siloxanes (PDMS) which are used in the pharmaceutical industry. They are tested according to the relevant monographs in the German Pharmacopoeia (DAB), which corresponds to the European Pharmacopoeia (Ph Eur), and meet the requirements of these monographs.

The number in the product nomenclature refers to viscosity measured in mm². PDMS are described in two monographs in the German Pharmacopoeias:

- "Dimeticon" with a viscosity range of 20 to 1000 mm² · s⁻¹. It should be taken into account that our PDMS are not manufactured according to GMP (= Good Manufacturing Practice) standards.
- Monograph VI.1.3.1 which is entitled "Silicone fluids for use as lubricants" and refers to a viscosity range of between 1000 and 30,000 mm² · s⁻¹.

In the United States Pharmacopoeia, the monograph "Dimethicone" refers to PDMS with a viscosity range of between 20 and 12,500 mm² · s⁻¹.

Grades

Sales products come in the following viscosities [mm² · s⁻¹]:

50; 100; 300; 350; 500; 1000; 1500; 5000; 12,500; 30,000.

Purity requirements and tests

These grades are all tested to ensure that the requirements specified by the DAB (Ph Eur) and the USP for PDMS are met. An analytical report containing the relevant data can be supplied on request.

A standard analytical report contains the results of tests on the following parameters:

- content of substances with an acidic reaction
- viscosity
- content of mineral oils
- content of phenylated compounds
- content of volatiles
- content of heavy metals

Tests on random samples showed that the germ count in Baysilone Fluids MPH conformed. No pathogenic indicator organisms were detected.

Information on the toxicological and ecotoxicological properties of PDMS is available on request.

Physiological and toxicological properties

Human studies have shown that PDMS is not absorbed in the gastro-intestinal tract following oral administration and has a laxative action. PDMS is a constituent of some antiflatulence preparations which prevent or resolve intestinal gas.

Information on the toxicological and ecotoxicological properties of PDMS is available on request.

Information on health and safety and handling information can be found in our safety data sheet.

Storage

Baysilone Fluids MPH keep for at least 12 months after delivery.

Baysilone®	Fluid MPH 50	Fluid MPH 100	Fluid MPH 300	Fluid MPH 350	Fluid MPH 500
Physical form	clear, colourless liquid				
Odour	odourless				
Density at 25 °C DIN 51757	0.97 g/cm³				
Viscosity at 25 °C	50 mm² · s⁻¹ ± 10%	100 mm² · s⁻¹ ± 10%	300 mm² · s⁻¹ ± 5%	350 mm² · s⁻¹ ± 5%	500 mm² · s⁻¹ ± 5%
Flash point DIN 51376	> 280 °C	> 300 °C	> 300 °C	> 300 °C	> 300 °C
Ignition temperature DIN 51794	> 400 °C				
Refractive index (n_{25}^{D}) DIN 51423	approx. 1.402	approx. 1.403	approx. 1.404	approx. 1.404	approx. 1.404
% Volatiles a) Dimeticon	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
b) Silicones as lubricants	–	–	–	–	–
Active ingredient content	100 %				
Heavy metals in ppm according to DAB (= Ph Eur)	≤ 5				
Soluble in	isopropanol, n-butanol, volatile hydrocarbons, methyl ethyl ketone and higher ketones, esters				
Insoluble in	water, lower alcohols (to C_4), acetone, long-chained hydrocarbons such as paraffin				

Baysilone®	Fluid MPH 1000 *	Fluid MPH 1500	Fluid MPH 5 000	Fluid MPH 12 500	Fluid MPH 30 000
Physical form	clear, colourless liquid				
Odour	odourless				
Density at 25 °C DIN 51757	0,97 g/cm³				
Viscosity at 25 °C	1000 mm² · s⁻¹ ± 5%	1500 mm² · s⁻¹ ± 5%	5000 mm² · s⁻¹ ± 5%	12500 mm² · s⁻¹ ± 5%	30000 mm² · s⁻¹ ± 5%
Flash point DIN 51376	> 300 °C	> 300 °C	> 320 °C	> 320 °C	> 320 °C
Ignition temperature DIN 51794	> 400 °C				
Refractive index (n_{25}^{D}) DIN 51423	approx. 1.404	approx. 1.404	approx. 1.404	approx. 1.404	approx. 1.404
% Volatiles a) Dimeticon	< 0.3	–	–	–	–
b) Silicones as lubricants	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Active ingredient content	100 %				
Heavy metals in ppm according to DAB (= Ph Eur)	≤ 5				
Soluble in	isopropanol, n-butanol, volatile hydrocarbons, methyl ethyl ketone and higher ketones, esters				
Insoluble in	water, lower alcohols (to C_4), acetone, long-chained hydrocarbons such as paraffin				

*For technical reasons we would like to know whether MPH 1000 should be tested according to the "Dimeticon" definition or the "Silicone fluids for use as lubricants" definition.

Chemical composition

Baysilone Fluid MH 15 is a polymethyl hydrogen siloxane with the following structure:

$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{Si}}}}-O-\left[\overset{\displaystyle CH_3}{\underset{\displaystyle H}{\overset{|}{\underset{|}{Si}}}}-O\right]_n-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{Si}}}}-CH_3$$

where n has a value of approx. 40.

Properties and reactions

The SiH groups contained in Baysilone Fluid MH 15 are susceptible to further chemical reactions, so that, in contrast to Baysilone Fluids M, Baysilone Fluid MH 15 can react with other substances. Thus, for example, the SiH bond reacts with water or compounds containing hydroxyl groups, with hydrogen being split off (caution!) as follows:

$$-\overset{|}{\underset{|}{Si}}-H+H-O-R\rightarrow-\overset{|}{\underset{|}{Si}}-O-R+H_2$$

This splitting off takes place even on contact with water or alcohol, so that the reaction described above must be expected in the case of aqueous or alcoholic preparations.

If R is a base-forming metal, e.g. sodium, calcium or other basic substances such as ammonia or amines, then the reaction occurs spontaneously.

With regard to further reactions entered into by the SiH bond, oxidation (e.g. by heating in air), substitution and addition are worthy of mention:

Oxidation

$$2-\overset{|}{\underset{|}{Si}}-H+\tfrac{1}{2}O_2\rightarrow-\overset{|}{\underset{|}{Si}}-O-\overset{|}{\underset{|}{Si}}-+H_2$$

Substitution

$$-\overset{|}{\underset{|}{Si}}-H+XR\rightarrow-\overset{|}{\underset{|}{Si}}-R+HX$$

(X = halogen for example)

Addition

$$-\overset{|}{\underset{|}{Si}}-H+R_2C=CR_2\rightarrow-\overset{|}{\underset{|}{Si}}-CR_2-CR_2H$$

Characteristics

Viscosity at 25 °C:	15 ± 2 $mm^2 \cdot s^{-1}$ (cSt)
Density at 25 °C:	0.99
Neutralisation value:	max. 0.02
Flash point:	> 150 °C

Solubility

Baysilone Fluid MH 15 is soluble in practically any ratio in all normal organic solvents such as hydrocarbons, chlorinated hydrocarbons, ethers, esters, aromatics and ketones, ethyl alcohol (99.5%) and higher alcohols.

Baysilone Fluid MH 15 is not soluble in water, methanol or ethanol (in concentrations of 96% or less).

Storage stability

Given appropriate storage conditions, Baysilone Fluid MH 15 will keep for a long time. In the presence of water or aqueous substances (emulsions, aqueous solutions, dispersion media and fillers), the shelf life is limited and dependent upon the pH. In the neutral range, the effect on storage stability is relatively slight. Whereas sufficient stability can still be achieved in the weakly acid range, decomposition sets in on exposure to highly acid or alkaline reagents. Even trace amounts of alkali cause hydrogen to evolve and the fluid to gel. The hydroxyl group of alcohols also reacts in this way, but to a much lesser extent than water.

Use

The uses of Baysilone Fluid MH 15 derive from the properties described above. Thanks to the reactivity of the SiH groups, Baysilone Fluid MH 15 can be adsorbed by unsaturated organic compounds such as polyester and methacrylate resins, and is thus able to bring about a modification of such products.

The conversion of compounds containing hydroxyl groups has also been referred to; this is important for the use of Baysilone Fluid MH 15 as a water repellent and impregnating agent for textiles, paper and leather, since it ensures stable siliconisation.

Finally, the above-mentioned oxidisability of the SiH bond at elevated temperatures (caused, for example, by atmospheric oxygen) is in many cases an advantage, for this also means that the applied film of silicone oil is more firmly anchored to the substrate. Thus, for example, Baysilone Fluid MH 15 is used to prevent agglomeration and hence to improve the free-flowing properties of fine-grain inorganic materials. The loading of previously dried fine-grain materials with Baysilone Fluid MH 15 is best carried out in a vat or mixer which can be heated to between 20 and 60°C. About 0.5 to 1.5% Baysilone Fluid MH 15 is sprayed into the granules, which are constantly stirred until even distribution is achieved. The temperature is then raised to 120°C for about 1 hour.

If elevated temperatures must be avoided for any reason (e.g. when treating certain colour pigments), then it is advisable to add Silopren Adhesive Trial Product AC 3023, an aminofunctional silane, or Silopren Catalyst 162, an organic metal compound. The catalyst is added after Baysilone Fluid MH 15 has been thoroughly mixed with the filler. 5 to 10% of the amount of Baysilone Fluid MH 15 has proved to be an appropriate quantity. On no account should both components be mixed together first! By adopting this procedure, the post-cure process can be dispensed with and the reaction time will be reduced to about ½ hour.

One further possibility is to introduce Baysilone Fluid MH 15 into the material in the liquid phase. The bulk material, for example glass beads, is added to a 0.5–1.5% solution of Baysilone Fluid MH 15 in chlorinated hydrocarbons; this solution is then removed and the material is subsequently heated for one hour at 220°C. If a catalyst is used, heating can be dispensed with, as above.

Baysilone Fluid MH 15 has also proved suitable for the water-repellent treatment of gypsum plasterboard and solid gypsum sheeting.

Water-repellent treatment of this sort is always necessary when such materials are used in kitchens, bathrooms, etc. The water-repellent treatment is applied in the pulp, i.e. the water-repellent agents are added directly to the other components during production of the plasterboard or sheeting.

In the past, aqueous emulsions were normally used for this purpose but these days pure silicone fluid (DE-PS 3429311) is more usual.

Generally speaking, the most economical process is water-repellent treatment with Baysilone Fluid MH 15 since it is a well-known fact that, calculated on the active ingredient content, fluids are most cost-effective. Consequently, changing to fluid products reduces costs. Silicone fluid is also more advantageous as far as storage is concerned.

Additions should be 0.2–0.4% fluid calculated on gypsum content. An addition of this amount of Baysilone Fluid MH 15, for example, reduces the water absorption of plasterboard after immersion in water for two hours (dipping test) as per DIN 18 180 to less than 10%.

In special cases where somewhat higher viscosity is required when using a polymethylhydrogen siloxane, we recommend the use of Baysilone Fluid MH 20. The reaction behaviour of this product is virtually the same as that of Baysilone Fluid MH 15.

Important note

Whenever working with Baysilone Fluid MH 15, it should be borne in mind that hydrogen may evolve under the reaction conditions which apply here (cf. the section on “Properties and reactions”). Precautions should therefore be taken to ensure that no combustible or explosive gas mixture can form.

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FLUIDS M

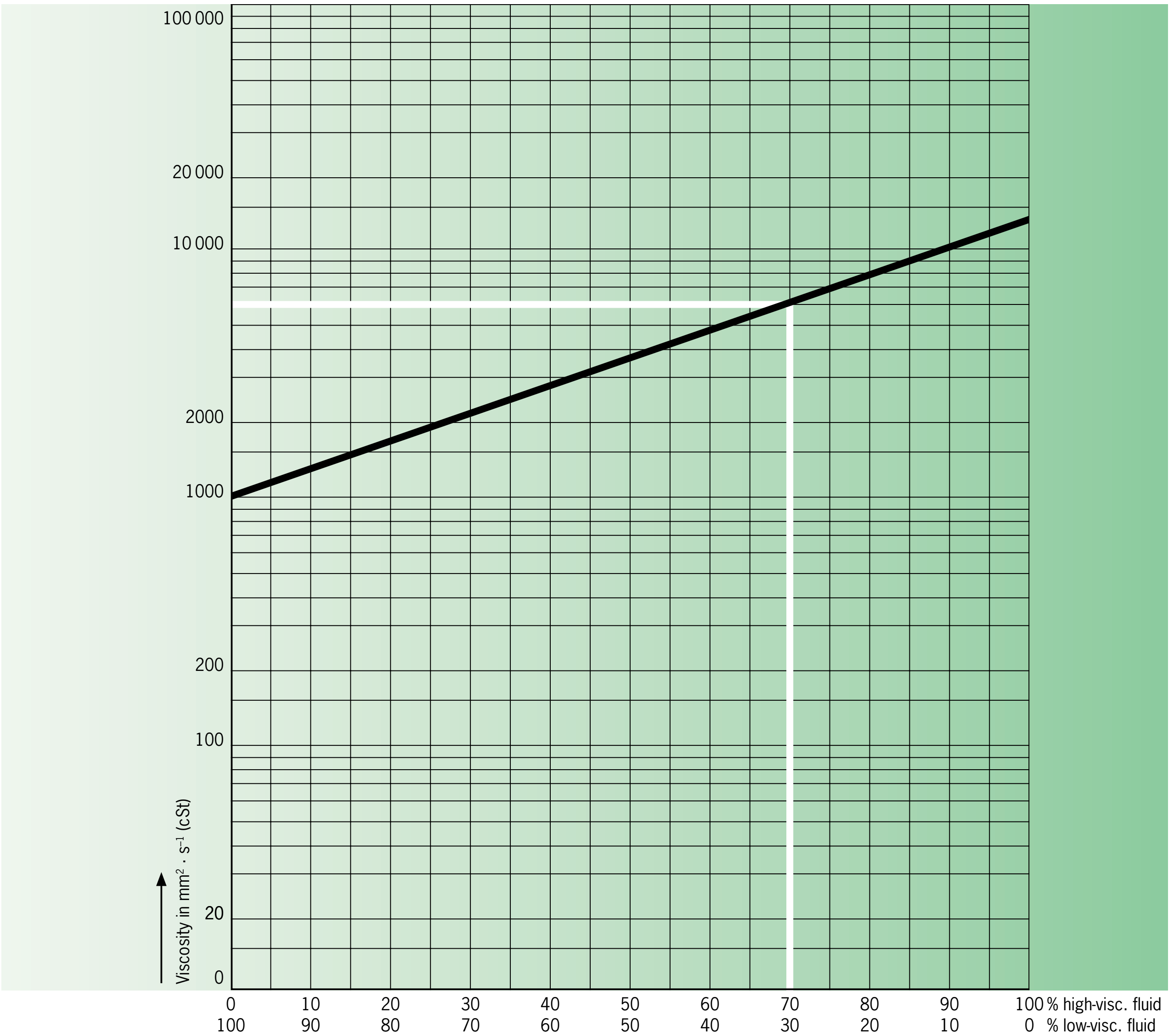

Fig. 1: Adjustment of the viscosity by blending

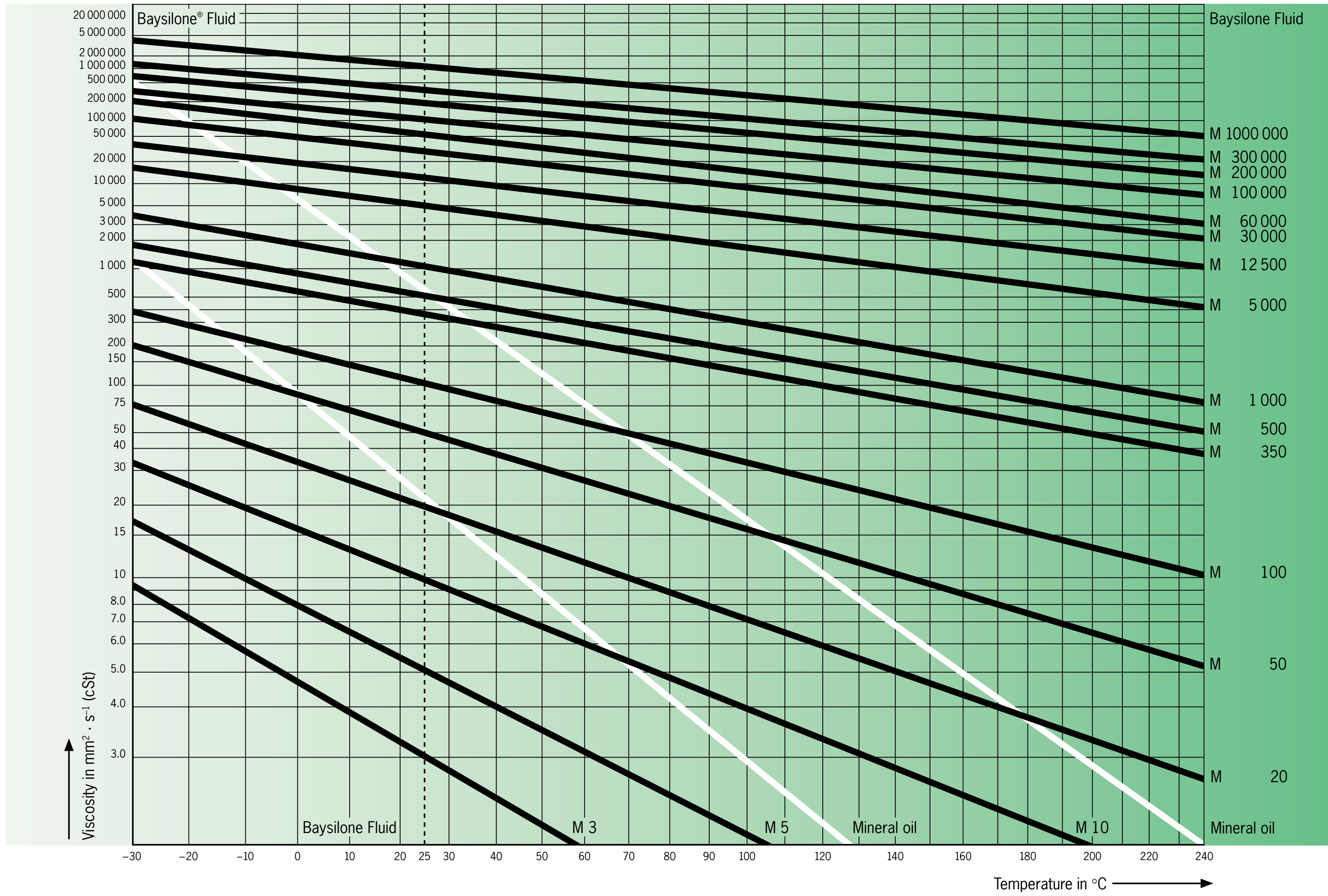

Fig. 2: The effect of temperature on the viscosity of Baysilone Fluids M as compared to mineral oils

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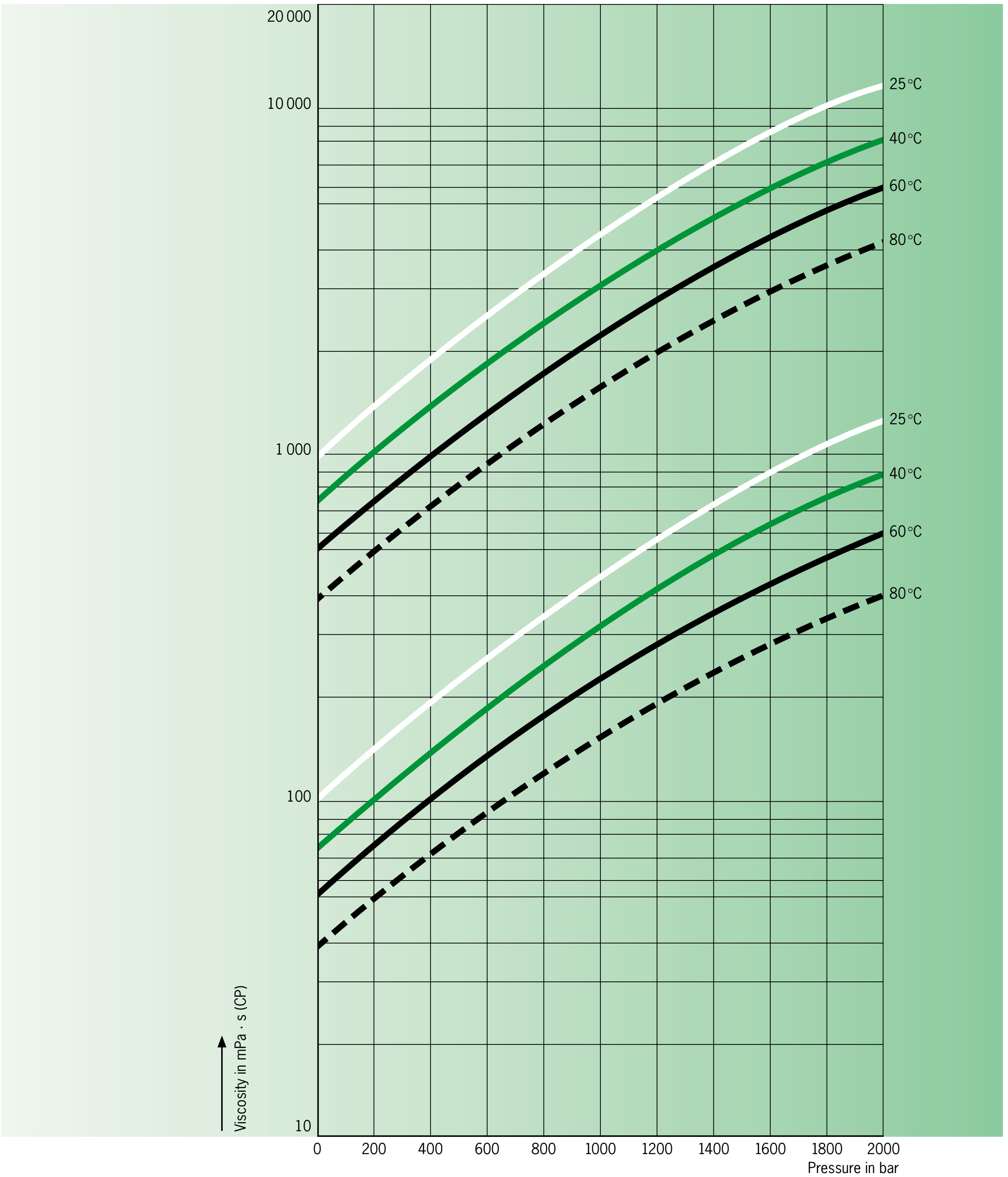

Fig. 3: The effect of pressure on the viscosity of Baysilone® Fluids M 100 and M 1000 at 25, 40, 60 and 80 °C (according to F. Kuss and GG. R. Schultze)

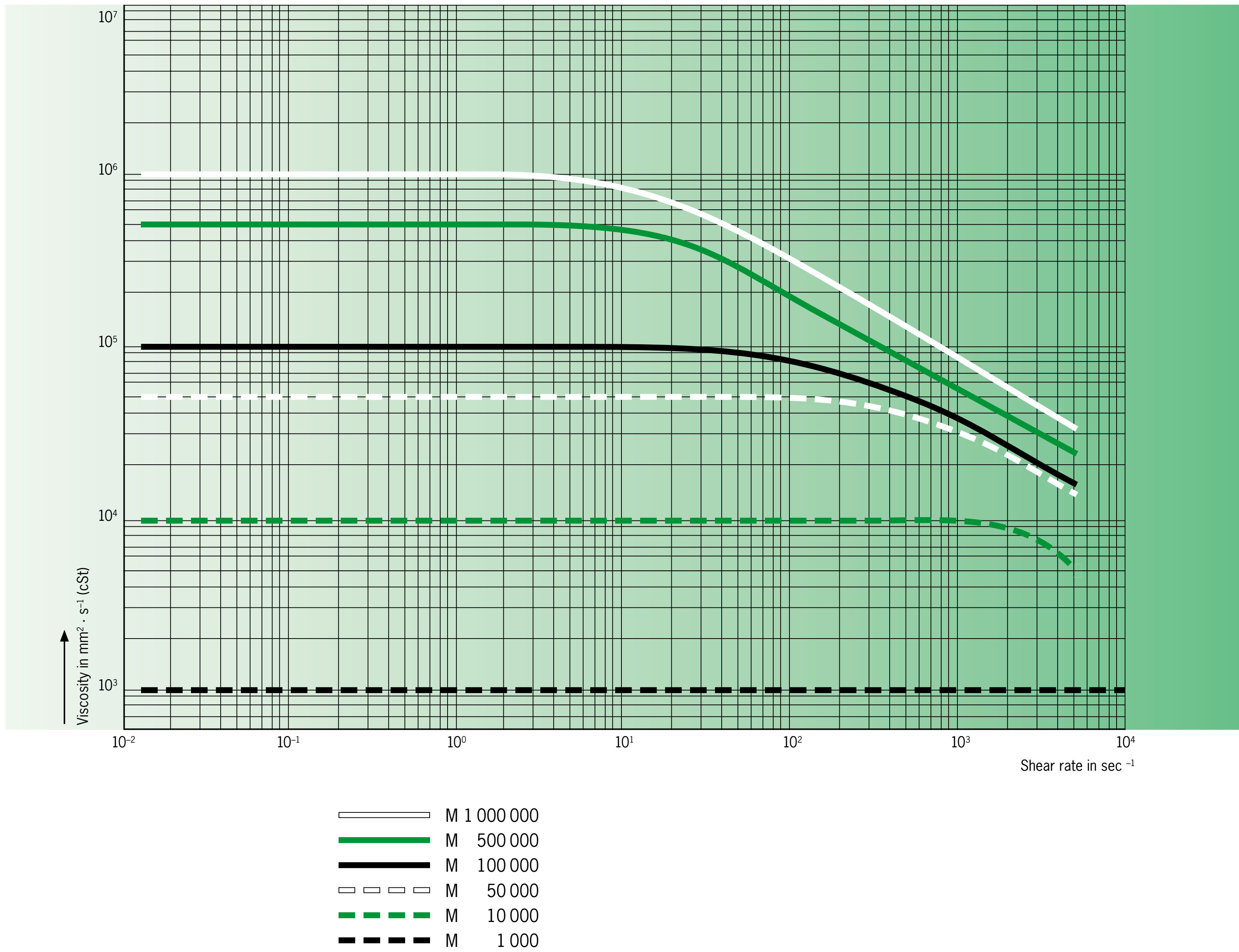

Fig. 4: The flow properties of Baysilone® Fluid M at 25 °C

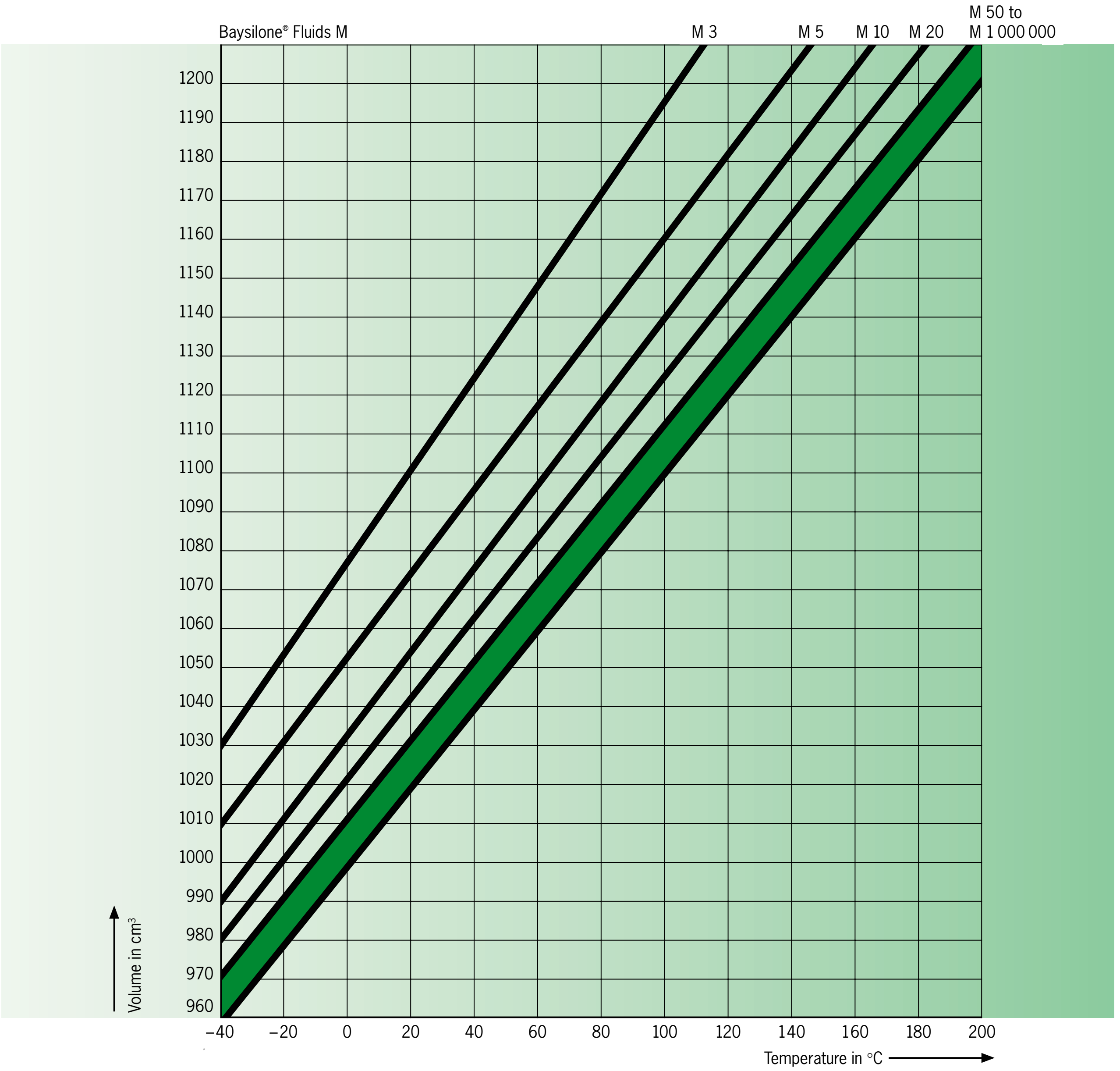

Fig. 5: The effect of temperature on the volume of Baysilone Fluids M

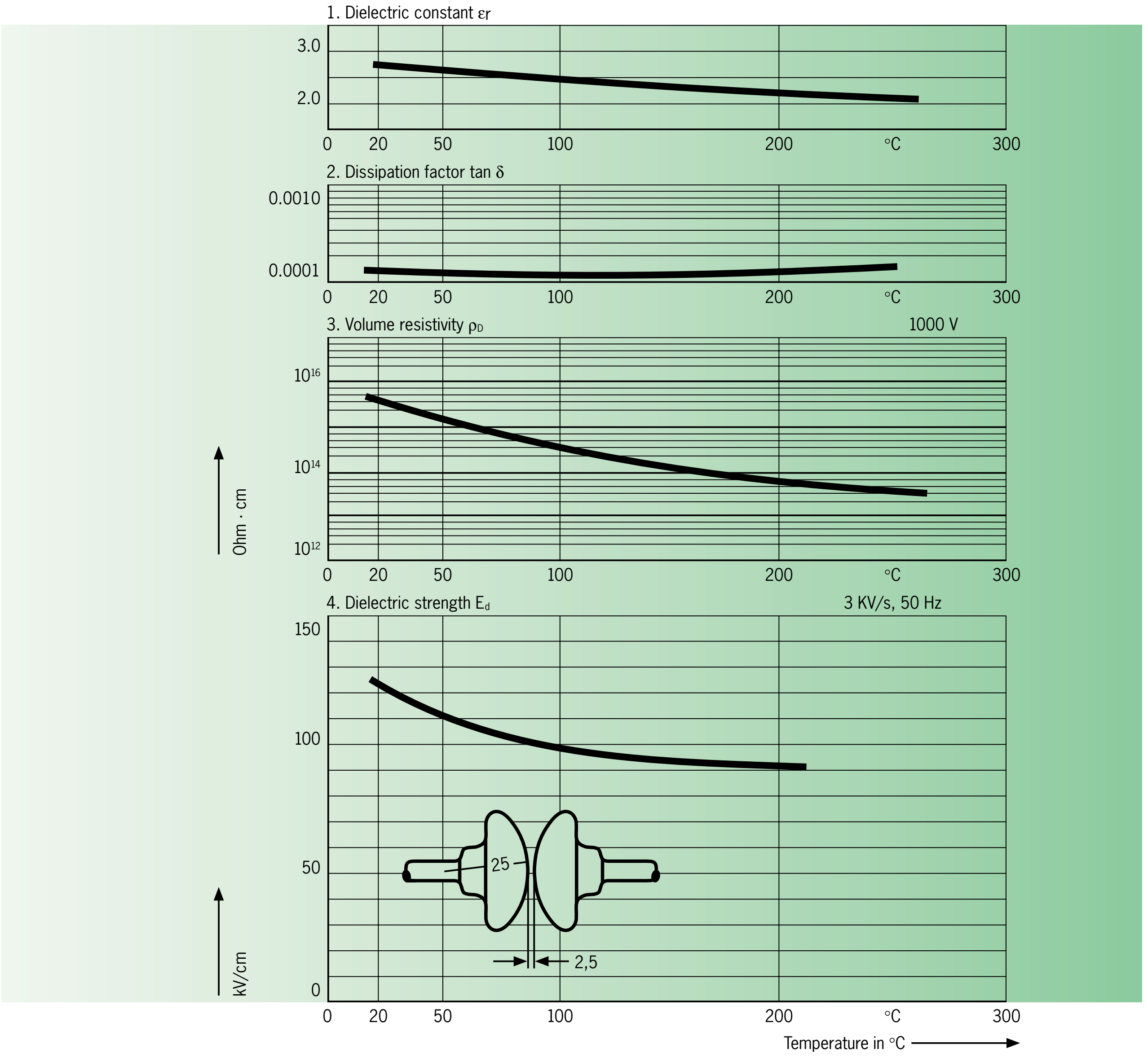

Fig. 6: The effect of temperature on the dielectric and electrical characteristics of Baysilone® Fluid M 350

BAYSILONE® FLUIDS M

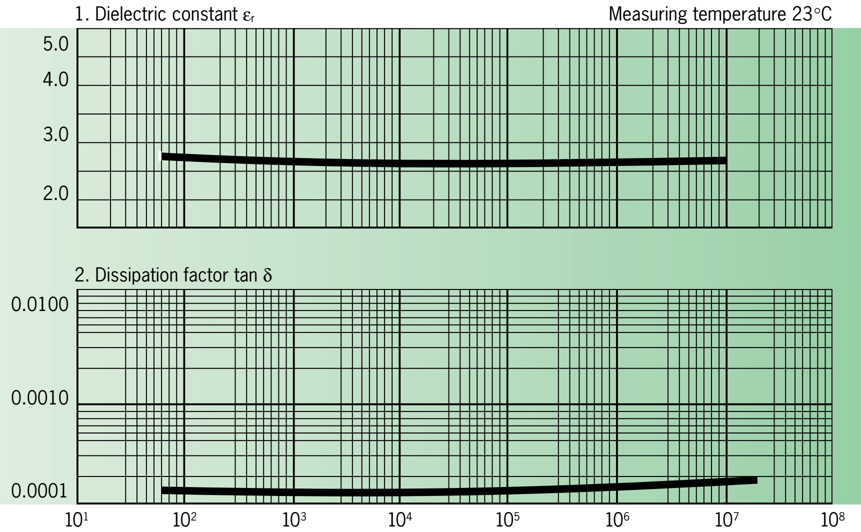

Fig. 7: The effect of frequency on the dielectric constant (ε_r) and the dissipation factor (tan δ) of Baysilone® Fluid M 350