SILRES® HK 46 AND SILRES® KX

Methyl Silicone Resin Solutions for Heat-Resistant Anti-Corrosion Coatings

The inorganic content of pure methyl silicone resins is much higher than that of phenyl methyl silicone resins. The combustion residue obtained from the solid resin typically has a SiO_2 content of approx. 87 – 88%. Both of these methyl silicone resin solutions are well suited for use as film-forming binders for heat-resistant, pigmented (corrosion-resistant) surface coatings.

What Do SILRES® HK 46 and SILRES® KX Have in Common?

- Tack-free drying at room temperature
- Curing by baking
- High flexibility and hardness
- No or poor miscibility with other organic binders
- Formation of a very hydrophobic surface (contact angle of approx. 98° with water)
- High inorganic content
- Solids content: 50 ± 1%

What Are the Differences between SILRES® HK 46 and SILRES® KX?

Because of its low viscosity, pure SILRES® KX requires the addition of pigments and fillers to raise the viscosity and improve the coating's flow properties when applied to metal surfaces. As such, we recommend adding HDK® H13L or HDK® N20 as a way of rendering the binder thixotropic. HDK® can also be used to improve the flow of SILRES® HK 46, even though the effect is significantly less pronounced. HDK® can be incorporated and dispersed using a bead mill with glass beads (typical laboratory disperser conditions: 30 min. at 5,000 rpm).

Comparison of the Properties of SILRES® HK 46 and SILRES® KX

	SILRES® HK 46	SILRES® KX
Drying rate	++	+
Flow properties	++	o
Molecular weight, Mw (average weight in g/mol)	80,000 – 120,000	8,000 – 15,000
Surface hardness after air drying	+	o
Surface hardness after baking	++	++
Viscosity [mm^2/s]	Medium (40 – 60)	Very low (6 – 12)
Solvent composition	Xylene: butanol 4:1	Xylene

Symbols used: ++ very good, + good, o satisfactory.

These figures are intended as a guide and should not be used in preparing specifications.

Typical Properties of Silicone Resin Films on Steel Surfaces

Product					
SILRES® KX	95.0 g	95.0 g			
SILRES® HK 46			95.0 g	97.0 g	100.0 g
HDK® H13L	5.0 g		5.0 g		
HDK® N20		5.0 g		3.0 g	
	Dispersion in a bead mill for 30 min. at 5,000 rpm				
Applied on Steel Plate Using a 100 µm Doctor Blade					
Drying time (23 °C / 44% RH)	4 h	4 h	45 min	45 min	45 min
Mechanical Test Results after Conditioning at RT for 7 Days					
Film thickness [µm]	25	26	24	25	27
Pendulum hardness[1]	5	-	77	65	66
Pencil hardness[2]	6B	5B	B	2B	2B
Cross-cut/adhesion[3]	0/0	0/0	0/0	0/0	0/0
Mechanical Test Results after Air Drying and Baking for 30 min. at 250 °C					
Film thickness [µm]	18	18	19	20	18
Pendulum hardness[1]	80	78	79	73	78
Pencil hardness[2]	6H	5H	6H	6H	6H
Cross-cut/adhesion[3]	0/0	0/0	0/0	0/0	0/0
Resistance to MEK[4]	> 150 DR	> 150 DR	> 150 DR	> 150 DR	> 150 DR

[1] ISO 1522
[2] ISO 15184
[3] ISO 2409
[4] ASTM D 5402-06

Formulation and Processing Properties

Heat-resistant surface coatings always consist of a formulation containing binders, pigments/fillers, additives and, in most cases, solvent. While liquid coating formulations containing SILRES® KX generally require less solvent/VOCs than comparable formulations containing SILRES® HK 46 as a binder, the final properties of coatings based on SILRES® HK 46 tend to be better.

The solid constituents must disperse adequately in the binder solution. The shear stability of aluminum pigments is often low and needs to be taken into account.

The formulation can be applied by any traditional method, such as spraying, rolling, dip coating or brush application. Optimum coating adhesion requires the metal surface to be bare, dry and free of grease.

The coating thickness should be between 20 and 50 µm. Excellent corrosion protection requires multiple coats. The thinner the coat, the lower the risk of cracking when temperatures are high or fluctuate abruptly.

Coatings are not solvent resistant after air drying and must be baked. Final curing begins at temperatures over 150 °C (300 °F) and depends on the formulation. Baking conditions of 250 °C (480 °F) for 30 min. are recommended for pure resin solutions. Aluminum pigments or metallic salts, for example, act as curing catalysts and reduce baking times and/or temperatures.

The methyl group of the resin undergoes increasing oxidative breakdown at temperatures over 250 °C (480 °F). When exposed to temperatures > 350 °C (660 °F) for extended periods of time, the remaining silicon dioxide matrix combines with the fillers and pigments to form very hard, poorly elastic coatings that adhere well to metals, glass and other similar substrates.

Combining resins with lamellar aluminum pigments maximizes the heat resistance – the dense, permanently bonded layer on the material can withstand temperatures of up to 650 °C (1,200 °F).

At a Glance

Coating properties on metal surfaces for formulations containing SILRES® HK 46 and KX:

- Tack-free air drying, curing by baking
- Excellent resistance to temperatures up to more than approx. 600 °C (1,110 °F)
- Good corrosion protection, especially in combination with zinc-rich primers

Typical Applications

SILRES® HK 46 and SILRES® KX are exceptionally well suited for (anti-corrosion) coatings on metal surfaces that are exposed to very high temperatures. Applications include mufflers, exhaust systems, engine components, boilers, furnaces, ovens and oven inserts, chimneys, grills, electric and gas heaters, and incinerators.

Sample Formulation for a Heat-Resistant Coating (Silver Gloss)

	[g]	Material
1	25.4	SILRES® KX
2	15.2	Talc [filler]
3	2.1	HDK® H13L (15% in xylene) [thickener]
		– Dispersion in a bead mill (30 min. at 5,000 rpm) –
4	31.8	SILRES® KX
5	25.4	Aluminum paste, 65% [pigment]
		– Dispersion (30 min. at 800 rpm) –
Σ	100.0	

Typical Coating Properties for this Formulation

Tack-free after air drying at room temperature in [min.]	90
Pencil hardness after 7 days at room temperature	4H
Pencil hardness after 1 h / 200 °C	9H
Heat stress: heated from room temperature to 600 °C in 3 h	OK, no visible defects
Cross-cut test after heating at 600 °C	1
Thermal shock: 5 x from 400 °C into cold water	OK, no visible defects
Salt spray test after heating at 400 °C on an ethyl-silicate-based zinc-rich primer	OK after 1,000 h of the salt spray test

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