

WACKER

CREATING TOMORROW'S SOLUTIONS

PER FORM ANCE

WITH HDK®.



PYROGENIC SILICA | COATINGS AND PRINTING INKS

**HDK® – THE PYROGENIC SILICA
WITH PERSONALIZED SERVICE**

SMALL AMOUNTS, BIG EFFECTS

Versatile HDK® Fulfills Many Needs

HDK® pyrogenic silica can help you optimize your coating and printing ink formulas in many ways. Even small amounts of HDK® in your total formulation can give your coating a competitive edge in delivering the crucial properties your customers require. Minor loadings offer your coatings flow control and ease of application.

In liquid coatings and inks, HDK® prevents hard settling and provides good flow during application, well balanced leveling and anti-sag properties. The proper rheology of your formulas is critical to your customers' satisfaction and HDK® is a valuable tool for making this happen.

HDK® is a key component in powder coatings and can optimize flow in loadings of less than one percent.

Individualized Support

The HDK® team's holistic approach supports you by taking into account the various factors that determine your success.

Technological Factors

Many factors are involved in selecting the right grade of HDK® for the best performance. The composition and production method of your coating, the application method, the substrate, and the final film properties must all be considered. We support you with technical recommendations, studies in our labs, and by supporting the lab or production trials in your plant. You can benefit from over 50 years of silica expertise and highly qualified experts.

Local Presence and Common Language

Local support is at hand with our technical service and WACKER Academy training centers. Our staff located in your region and time zone can advise you in your own language.

Regulatory Compliance

HDK® is compliant with major substance inventories worldwide. This includes registrations under Regulation (EC) No. 1907/2006 (REACH), covering supply of HDK® to the European Economic Area by Wacker Chemie AG and its affiliates.

Personal Support

Our HDK® team gives you access to qualified experts you can approach directly. We foster a culture of long-term expertise, relationship and continuity.



Any questions?

Just get in touch with us.

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PURE SILICA, PURE PERFORMANCE

Experience Counts

We have produced HDK® pyrogenic silica for over 50 years. Our integrated production system, statistical process control and highly efficient reactor dynamics make our pyrogenic silica exceptionally pure and offer high performance.

HDK® pyrogenic silica is made by hydrolysis of chlorosilane in an oxyhydrogen flame. The process yields HDK® as highly branched aggregates which are the basic building block of our pyrogenic silica. These form weakly bound agglomerates upon cooling. The HDK® made in this reactor is hydrophilic. By post-treatment in a second reactor, we are able to offer hydrophobic HDK® grades that are key to rheology control in polar systems. Hydrophobic grades can also enhance anti-corrosion properties in some coatings.

How HDK® Works

HDK® has an exceptionally high surface area to mass ratio. This enables many particle interactions in liquid formulations and helps to build a three-dimensional physical network. This network is the basis for the rheology control HDK® provides.

Obtaining optimal rheology for your coating or ink depends on getting the specific surface area right and selecting the correct hydrophilic or hydrophobic HDK® grade. Our broad portfolio provides the ideal solution for nearly any formula.

Properties of HDK®

- Ultrapure synthetic inorganic additive
- Neutral color and inert
- Migration resistant
- Thermally stable
- Non-hazardous

Benefits of HDK® in Coatings:

- Highly effective at low dosages of usually < 2 wt%
- Highly effective anti-settling and anti-caking agent
- Constant viscosity throughout storage
- Enhanced anti-corrosion properties with hydrophobic HDK®
- Control over sagging and leveling behavior
- Improved alignment of effect pigments
- Control over flow and fluidization properties of powder coatings

MAKING THE MOST OF YOUR VISCOSITY

Superior Rheology Control in Liquid Coatings

Rheology control is essential for the manufacture, storage and processing of any coating. HDK® allows meticulous adjustments of the rheological properties of all key liquid coating types.

Adding HDK® will increase the viscosity of the liquid phase in a liquid coating formulation and influence shear thinning and thixotropic flow behavior. In general, HDK® grades with a higher specific surface area yield more pronounced rheological effects, while grades with a lower specific surface area are easier to disperse.

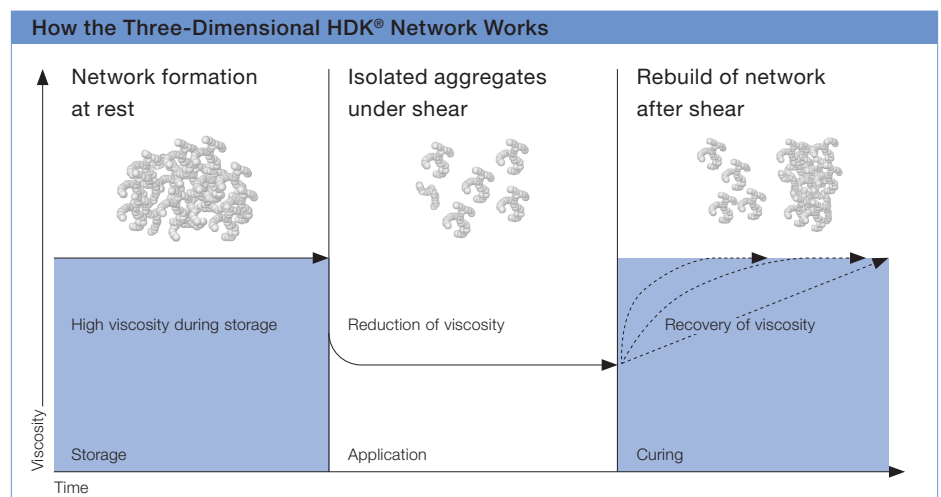
What grades will yield the best results in your formulation? Just get in touch with us and we will gladly support you.

TIP

If your primary focus is anti-settling, low dosages (0.5 to 1 wt%) of hydrophilic HDK® N20 or hydrophobic HDK® H15 or HDK® H13L will suffice. In many systems hydrophobic HDK® achieves better storage stability.

Optimal Viscosity at All Times

Due to electrostatic interactions, HDK® dispersed in coating formulations creates a three-dimensional network. This network initially increases your formulation's viscosity to a desired consistency based on loading level, which prevents settling during storage. When shear forces (shaking, pumping or spraying) are applied, the branched network breaks up and the viscosity decreases (shear thinning). After application, the HDK® network reforms and the viscosity increases again (thixotropy), ensuring levelling without sagging, and that your formulation's resting state is stable during curing.



TIP

To increase thixotropy and anti-sagging, raise the HDK® dosage to 1 to 2 wt%. High-build coatings may even require up to 4 wt% for best results.



SO MANY USES: HDK® IN LIQUID COATINGS

Control of Settling Behavior in Baking Primer Surfacer

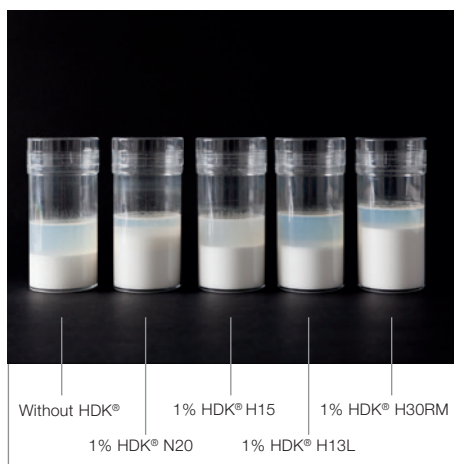
Coating systems that contain pigments and heavy fillers, like PUR primer surfacers for example, will show substantial settling after only a few weeks' storage time. You can prevent this by adding approx. 0.5 to 1 wt% HDK® to your formulation. Hydrophobic HDK® grades and grades with a higher surface area enhance effectiveness in most formulations.

TIP

You can use hydrophobic HDK® grades to fulfil requirements other than anti-settling – like for example, making cured coating films water repellent or delivering anti-sag characteristics at elevated temperatures (baking systems).

Composition of Primer Surfacer

Binder	Polyester
Solvent	Water
Pigmentation	Titanium dioxide
Filler	Barium sulfate
Solids content	51%
Dispersion	Bead mill



Anti-settling effect in aqueous PUR primer. Even after a short storage period of only one month, the anti-settling effect of HDK® is clearly visible.

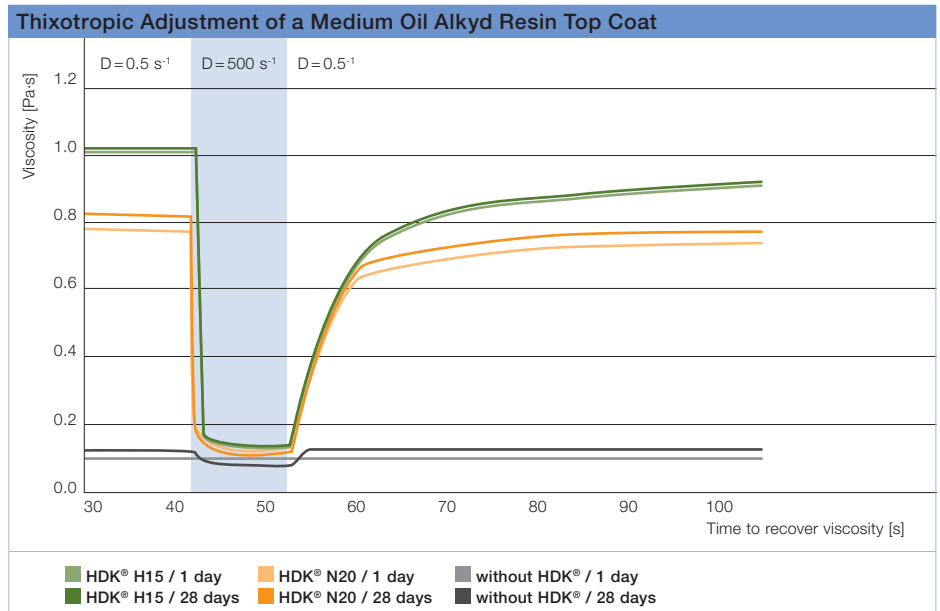


Rheological Adjustment of High Solid Coatings

Adding 0.7% HDK® with a medium specific surface area to your alkyd resin-based top coat systems will give them a pronounced thixotropic effect that is stable in storage. It will also enhance the sag resistance of the coatings considerably. In coating systems of medium polarity hydrophilic and hydrophobic HDK® grades will achieve similar rheological effects, while the hydrophobic grade will show slightly better storage stability.

Composition of the Top Coat	
Binder	Medium-oil alkyd resin
Solvent	Aliphatic/aromatic 8:2
Pigmentation	Titanium dioxide
Solids content	51%
Dispersion	Bead mill

Test of Sag Resistance on Glass (ASTM D4400)	
Without HDK®	~ 30µm after 1 day and after 28 days
0.7wt% HDK® N20	~ 60µm after 1 day and after 28 days
0.7wt% HDK® H15	~ 70µm after 1 day and after 28 days



TIP

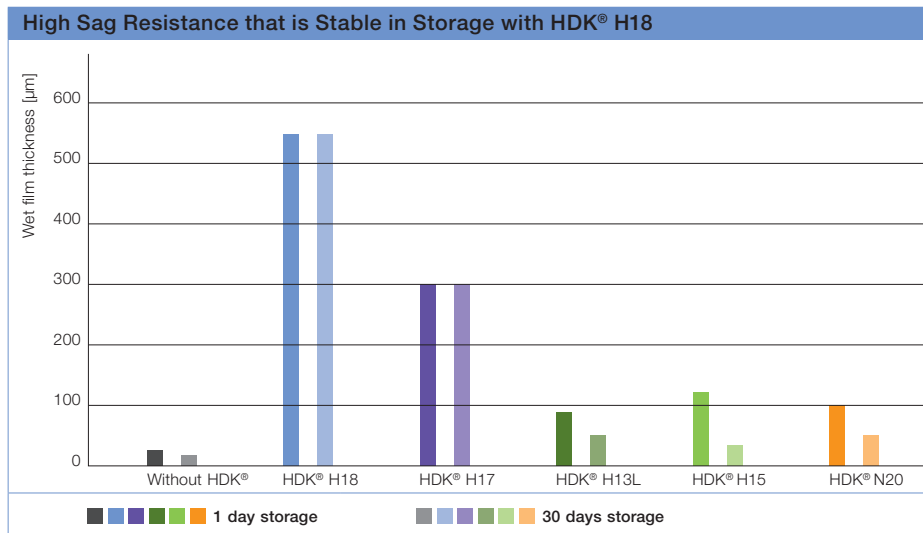
Using hydrophobic HDK® H15 results in approx. 15% more thickening and slightly enhanced storage stability as compared to hydrophilic HDK® N20.

This graph shows the thixotropic properties of alkyd resin coatings. If higher thixotropy and storage stability are your focus, you should prefer HDK® H15 over HDK® N20.

Sag Resistance for Epoxy High-Build Coating

The epoxide high-build coating example illustrates that HDK® can be used to satisfy the most stringent demands for sag resistance and storage stability. HDK® H18 is the ideal grade to use here. The graph below shows that this hydrophobic grade achieves the best sag resistance,

and it is stable in storage. This is essential for heavy-duty corrosion protection coatings as well as many other 2K epoxies. An alternative is HDK® H17, which is easier to disperse, but results in a less pronounced rheology performance.

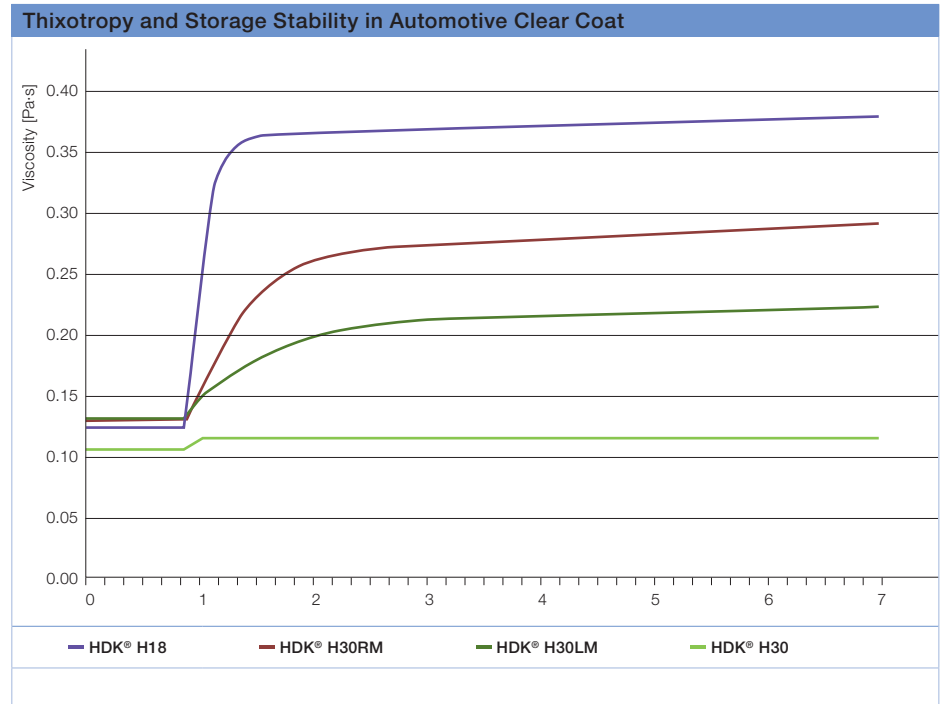


Composition of Two-Component High-Build Coating	
Binder	Liquid epoxy resin
Solvent	n-Butanol, xylene
Pigmentation	Titanium dioxide
Extender	Barium sulfate
Solids content	80%
Dispersion	Dissolver
Curing agent	Cycloaliphatic amine

Two-Component PU High-Solids Clear Coat

To achieve a brilliant finish, your clear coats must feature excellent thixotropic and leveling properties at the same time. Moreover, they must satisfy high requirements on transparency, gloss and durability.

The high specific surface area of our HDK® grades H30LM and H30RM guarantee excellent optical properties and storage stability. H30RM has slightly more pronounced hydrophobic character than H30LM.



Thixotropy leap from a shear rate of 100s^{-1} to 1s^{-1} in an automotive clear coat containing 0.9% HDK®.

TIP

Hydrophobic HDK® grades H30LM and H30RM are silane-modified. Add 1 wt% to your formulation for optimal control over coating thickness and leveling in high-solids systems of medium polarity.

Composition of Automotive OEM Clear Coat

Binder	Polyacrylate polyol, polyester polyol
Solvent	Ester, glycol ester
Solids content	45%
Curing agent	HDT
HDK® dosage	1%
Dispersion	Bead mill

GET BETTER FLOW

HDK® in Powder Coatings

For your powder coatings, you want good flow and fluidization properties during processing, storage and especially application. Adding only a small amount of HDK® will achieve this. When mixed with a powder coating formulation, HDK® agglomerates of submicron sizes will accumulate on the surface of the binder particles and act as spacers. This reduces the agglomeration of the binder particles, so the consistency of the powder coating can be enhanced and maintained.

Depending on the composition of your powder coating, hydrophilic grades are very effective, while hydrophobic HDK® grades can reduce moisture absorption and promote extended storage periods.

Practical Benefits

- Low dosage of 0.1 – 0.5 wt% based on total formulation is sufficient
- Retention of flow properties throughout storage
- Easier and quicker sieving; better fluidization properties during application
- Retention of the electrostatic wrap effect
- No influence on film formation or curing

TIP

For best results, add hydrophilic HDK® N20 or HDK® T30 or hydrophobic grades HDK® H13L or HDK® H30 during grinding or dry blending.

SHARP AND CLEAN

HDK® in Printing Inks

Formulating printing inks frequently presents formidable challenges with respect to rheological effects. Printing is a high-speed mechanical process and the rheology of the ink has to cope with a variety of physical forces to achieve perfect results. Printing inks should not sputter while being transferred onto a substrate. They need to dry fast and must be finely adjusted to the surface qualities of the substrate to deliver sharp images on paper, polymer materials or metals. The surface should be tack-free very soon after printing. HDK® provides inks with the right rheological profile to meet these stringent requirements.

In addition to settling and rheology control, HDK® optimizes the application characteristics in printing inks in several ways:

- Smooth transfer of the printing ink to the print medium
- Superior image due to sharper contours
- Fresh prints do not smear
- Regulation of water balance in offset printing inks reduces water uptake for advanced print sharpness

TIP

In our experience, the hydrophilic grades HDK® N20 and HDK® T30, as well as the hydrophobic grades HDK® H15 and HDK® H13L, work best for formulating printing inks with dosing levels from 0.3% to 1% by wt.



DISPERSION: A CRITICAL FACTOR

Tips for Incorporation



The design of the mixing or milling equipment used for the dispersion of HDK® is essential to successful performance. Reproducible and optimum rheology performance will only be achieved if HDK® is well dispersed in the coating system. In addition, the optical properties of a coating film (e.g., gloss, haze) will improve with the degree of HDK® dispersion. Good dispersion is the result of the quality of the shearing force applied (dispenser design, size, speed and power) and the dispersion time. However, to obtain good dispersion quality, the shear force applied during dispersion must meet a certain minimum. Longer dispersion times will improve dispersion but if the shear force

is inadequate, optimum dispersion will not be achieved – even over an extended dispersing time. A dissolver does not always supply sufficiently high shear force for dispersing HDK®. For low viscosity systems, high shear dispersers such as stator-rotor mixers or bead mills should be considered. For systems with higher viscosities, on the other hand, a dissolver can achieve adequate grind values of 20 µm. For the user, this means that a dissolver should not be used for HDK® dispersion where stringent optical properties are required.

Pigmented Systems

In pigmented systems, first add HDK®, and when wet out, add pigments and disperse together.

Clear Coats

For clear coats, the master batch method has proven a suitable alternative to direct dispersion. Here, a higher HDK® concentration of approx. 5% is initially dispersed in the binder-solvent matrix. The desired HDK® concentration is obtained in the final let-down. This means that the optimum degree of dispersion can be even more reliably achieved and, at the same time, production processes can be made more efficient.

BRINGING SUPERIOR SERVICE CLOSER TO YOU

Expanding our Global Presence

New Capacity in North America

WACKER's state-of-the-art facilities in Europe and China produce a variety of pyrogenic silica grades, including nutritional and pharmaceutical products. Furthermore, our newest production plant is set to go onstream in Charleston, TN, USA, in 2019. With an annual capacity of about 13,000 metric tons, the new facility will be a key component of the Charleston site, which produces polysilicon for the solar and semiconductor sectors. By integrating the polysilicon and HDK® production systems, WACKER can achieve maximum flexibility, less waste and enhanced efficiency. This facility will open up new avenues for customers seeking an on-shore supplier in North America.

Optimal Packaging, Optimal Performance

In order to ensure maximum effectiveness of your products and formulations, we offer various forms of packaging, to suit your logistics and workflow requirements. Packaging size, effective moisture protection, and your specific requirements are important factors in determining the optimal HDK® packaging for your productivity.

Pallets with Paper Bags

HDK® is available in multilayer, valved paper bags which can accommodate 5 to 20 kg of product, depending on bulk density. The bags are delivered on pallets, that are shrink-wrapped with a polyethylene film for moisture protection. If the shrink film is damaged accidentally or

single bags are removed, it is advisable to protect remaining or individual bags either by wrapping them in plastic or adopting other appropriate measures.

Big Bags

The big bag solution is available for most HDK® grades. Big bags are made of woven polypropylene and are suitable for 150 to 200 kg of product, depending on bulk density. Big bags are delivered on pallets shrink wrapped with a polyethylene film as a safeguard against moisture.

We also provide advice on how to handle the material, and in particular, how to fluidize and unload big bags.

Please contact us for further information.



Pallets with paper bags



Big bag

EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS



• Sales offices and production sites, plus 21 technical centers, ensure you a local presence worldwide.

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.92 billion. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life based on

energy efficiency and protection of the climate and environment. Spanning the globe with 4 business divisions, we offer our customers highly-specialized products and comprehensive service via 23 production sites, 21 technical competence centers, 13 WACKER ACADEMY training centers and 50 sales offices in Europe, North and South America, and Asia – including a presence in China. With a workforce of some 13,800, we see ourselves as a reliable innovation partner that develops trailblazing solutions for,



and in collaboration with, our customers. We also help them boost their own success. Our technical centers employ local specialists who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required. WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and

reliable service to enable projects and orders to be handled fast, reliably and highly efficiently.

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All figures are based on fiscal 2017.

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