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WACKER

WACKER AT ECS 2019

All our product innovations across 68 pages

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PROGRESS ON A PROVEN BASIS

Dr. Rudolf Staudigl, President and CEO of Wacker Chemie AG

Dear Reader,

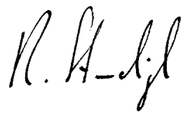
Polymer binders based on vinyl acetate and ethylene are among the products that add pleasure and comfort to our lives. The variety of applications for the construction industry alone ranges from dry-mix mortars to tile adhesives, self-leveling flooring compounds and interior paints. Our WACKER POLYMERS business division has an edge on the market thanks to its innovations, new developments and the high quality of its products. The construction industry expects ever higher standards of quality. Emerging markets, too, are increasingly placing more value on efficient construction methods, sustainability and high-tech building materials. This is driving demand for polymer-modified mortars, which have long been standard fare among industrialized countries.

WACKER is continuously striving to enhance the properties of its vinyl acetate-ethylene (VAE) copolymer-based products. With a world market share of over 50% for dispersible polymer powders and over 30% for dispersions, we are a global player in the field of vinyl-acetate-based binders. Yet our experts are well aware that the construction industry attaches great importance to solutions adapted to local raw materials, standards and climatic conditions. That's why WACKER POLYMERS maintains a global network of 15 technical competence centers, where we intensify dialogue with our customers and collaborate with them to develop solutions that meet their needs.

At the European Coatings Show, WACKER is introducing polymer binders that improve the properties of ecolabel interior paints, bitumen emulsions, waterproofing membranes and tile adhesives. All our ECS innovations demonstrate how we develop new products based on over sixty years of tried-and-tested technology and tailored to the individual requirements of our customers. In this issue of our company magazine, we show you how we tailor our vinyl acetate-ethylene copolymers to new, sophisticated applications.

"Emerging markets, too, are increasingly placing more value on efficient construction methods, sustainability and high-tech building materials."

I hope you enjoy reading this issue.



Dr. Rudolf Staudigl
President and CEO of Wacker Chemie AG

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Here you'll find all of this issue's articles at a glance.

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VINNAPAS® EP 3560

A HEALTHIER HOME

Anyone who is doing painting and decorating and is reluctant to bring harmful substances into their house will choose paints that bear ecolabels. VINNAPAS® EP 3560 is a new WACKER binder for interior wall paints. It offers a compelling blend of high-end properties and an extremely low level of harmful substances.

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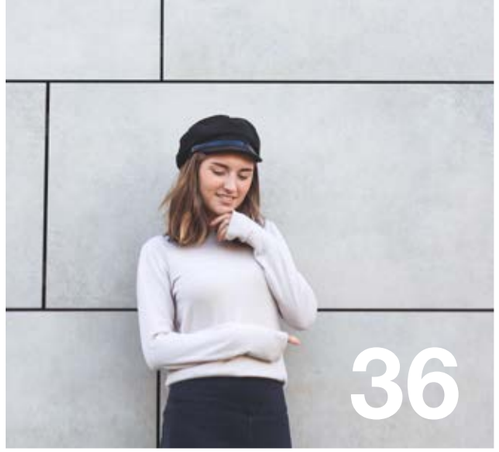

NEWS

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SOLUTIONS

INNOVATIONS

WWW 1.19 ▸ GLOBAL ▸ **WACKER WORLDWIDE**

WACKER WORLDWIDE

WACKER has production sites, application technology centers, subsidiaries and sales offices on every continent. Here is a selection of news and interesting topics from the Group's four business divisions.

1 LAS VEGAS

Slimmer, bigger, sharper: in early 2019, manufacturers presented high-resolution TVs with 8K technology and up to 98-inch screens (a huge 2.49 meters) at CES in Las Vegas, USA. Such high-end devices set new standards in home cinema. The trend toward flexible displays continues unabated. Examples on show included a foldable smartphone and the prototype of a large TV display that can roll up automatically. The outstanding properties of WACKER's ELASTOSIL® silicones make them indispensable. Even in critical applications, silicones operate reliably throughout their service life and are fireproof, making them ideal for use in cellphones and all kinds of modern-day electronic devices.

2 CALVERT CITY

A new cooling tower at WACKER's Calvert City plant in Kentucky, USA, has made a lasting improvement to the site infrastructure. The tower consists of four cells and replaces the original cooling units dating from the 1960s and 1970s. The new cooling-water system has been fitted with state-of-the-art control devices. Its four pumps each have a 800 PS rating and can supply up to 180,000 liters a minute. What's more, a new use has been found for the ten pumps from the original cooling towers: they were donated to the city of Brookport, Illinois, some 23 miles away, where they will help expand the pumping station on a levee (flood-control embankment).

3 MUNICH

WACKER's corporate research facility – the Consortium – relocated from Nuremberg to Munich on September 10, 1918. In pre-internet days, access to Munich's two universities and associated libraries was an absolute necessity for Consortium chemists. Then as now, research was market-driven. The Consortium currently focuses, for example, on silicon chemistry, biotechnology and lithium-ion batteries. It is, incidentally, older than WACKER itself. Alexander Wacker founded the "Consortium für elektrochemische Industrie" on March 25, 1903. "Dr. Alexander Wacker, Gesellschaft für elektrochemische Industrie, KG" was not entered in the Traunstein Commercial Register until more than eleven years later, on October 13, 1914.

4 BURGHAUSEN

WACKER has opened a scale-up laboratory at its Burghausen site. The Group can use the new lab to advance innovations to production readiness. Leveraging close, interdepartmental collaboration between chemists and engineers, this lab provides a custom-designed R&D set-up outside of existing production plants. New methods can be developed on an industrial scale from 1 to 100 kilograms at the facility. The pilot plants will be tailored to each project and operated by the project sponsor's employees under the expert leadership of the central Process Development Unit.

5 NEW DELHI

Urban dwellers in India are suffering from increased levels of traffic and, in particular, smog. According to a study published in late 2018 by the University of Chicago, air pollution in New Delhi is actually so bad that the life expectancy of residents is 10.2 years lower than elsewhere. To counteract this trend, the Indian government and the automotive industry want to boost the number of electric vehicles on roads. Last year, various models were introduced – many of them developed or produced in India. The portfolio ranges from electrically driven scooters and motorcycles to auto rickshaws and full-size SUVs. WACKER offers numerous silicone products that are ideal for electromobility applications.

GROUP UPDATE

WACKER AND FUJI POLYMER DEVELOP SILICONE-BASED THERMAL INTERFACE MATERIALS

Companies cooperate in the field of thermally conductive plastic for the automotive and electronics sectors

SARCON® thermal gap filler pads from Fuji Polymer Industries are highly conformable, thermally conductive gels in versatile sheet form. They adhere to all shapes and sizes of components, even when they feature protrusions or recessed surfaces.

Although WACKER and Fuji Polymer Industries both produce silicone-based thermal interface materials for industrial applications, the range of products supplied by each company is different. WACKER produces uncured liquid or paste-like silicones that it supplies in the form of gels, encapsulants, adhesives and sealants intended for metering processes. Fuji Polymer Industries, on the other hand, makes ready-to-use silicone elastomer components such as contact mats, films and pads for the electronics industry and automotive suppliers.

The companies intend to intensify and broaden this collaboration in the future. “Both WACKER and Fuji Polymer Industries are experts in their fields and possess a vast knowledge of the formulation and processing of thermally conductive silicones – WACKER when it comes to liquid systems, Fuji Polymer Industries for ready-to-use components,” said Christian Gimber, head of Engineering Silicones at WACKER SILICONES. “We will be redoubling our collaboration in the future with a view to jointly developing innovative materials that meet the constantly growing demands of the electronics and automotive industries.”

Fuji Polymer Industries exhibited the first fruits of this new collaboration at the International Automotive Electronics Technology Expo 2019 in Tokyo. “Electronic devices and batteries generate a great deal of heat that impacts their functionality and service life and can lead to serious faults. Efficient thermal management is therefore growing increasingly essential in many applications, such as consumer electronics and electric vehicles,” said Gimber. To better cool the components, the industry is turning more and more often to heat-dissipation materials, he added. “Our thermally conductive silicones not only can be processed efficiently, but also take account of the stringent safety and reliability demands imposed by the electronics and automotive industries.”

Fuji Polymer Industries, too, stands to benefit enormously from the development partnership. “This collaboration with WACKER is hugely important for us. It means, first, that we can benefit from the technical expertise of a leading silicones producer for our development work. And, second, we can now affix the “Based on ELASTOSIL®” logo to our thermally conductive silicone products. In this way, our customers will know that only high-quality silicones from WACKER were used in the manufacture of those products,” said Mitsuhiro Fujimoto, board member at Fuji Polymer Industries.

EXPANSION OF SILICONE RUBBER PRODUCTION

WACKER launches capacity expansion and invests €100 million in specialty rubber portfolio

Silicone rubber is among the most sought-after elastomers in the industry. “Silicones are high-performance materials. They are essential for novel product solutions and belong to the innovation drivers in key industries, such as the automotive, medical, and electronics sectors,” said Dr. Robert Gnann, president of the WACKER SILICONES business division. Above-average growth is being driven by the trends toward hybrid cars, electromobility and digitalization, as well as decentralized alternative electricity generation using wind and solar power.

With expansion measures at several sites, WACKER plans to gradually raise its specialty-rubber capacities by a total of 40,000 metric tons per year by 2021. Approximately €100 million has been earmarked for this capacity expansion. All solid silicone rubber product groups will benefit from these expansion measures. In April 2018, WACKER brought a new production site for silicone sealants and thermally conductive silicone compounds on stream in Jincheon, South Korea. In addition, the production of room-temperature-curing silicone elastomers and liquid silicone rubbers has started in Amtala, India, where WACKER manufactures silicones in a joint venture with Metroark.

For 2019, the chemical group is planning further capacity enhancements for liquid silicone rubber, high-temperature-curing and room-temperature-curing silicones and thermally conductive silicone compounds at its production sites in Burghausen (Germany), Adrian (Michigan, USA) and Zhangjiagang (China). WACKER is also evaluating the option of building a plant for solid silicone rubber at its Charleston site in Tennessee, USA. WACKER has been producing polysilicon there since 2016. A plant for manufacturing pyrogenic silica, an important filler for high consistency silicone rubber (HCR), will come on stream at the site this year.

Image above: containers (pails) in a warehouse for ELASTOSIL® liquid silicone rubber, waiting for shipment
Image on right: mixing equipment used to process silicone rubber

WACKER AMONG THE MOST HIGHLY REGARDED GERMAN COMPANIES

WACKER takes fourth place in the Statista reputation analysis of 300 German organizations

In 2018, WACKER came fourth among 300 companies and organizations analyzed in the annual reputation analysis by the market research portal Statista and the financial magazine brand eins. In the chemical, pharmaceutical and biotechnology industries, Wacker Chemie AG even surpassed all other companies, taking first place.

For the study, the market researchers from Statista polled over 5,000 people about companies they had already been involved with as business partners, employees or customers. The responses were subsequently supplemented with appraisals by 289 prominent experts from various institutions, including representatives of universities, management consultants, editorial boards, and advertising and PR agencies. The assessment also took into account financial indicators. According to Dr. Friedrich Schwandt, CEO of Statista, “Financial stability typically forms a reliable basis for acting as a long-term (business) partner, as well as being the result of good entrepreneurship.”

“All our employees can be proud of the results of this study,” explained Dr. Rudolf Staudigl, President & CEO of Wacker Chemie AG. “This shows us that we are on the right track with our corporate positioning, and that this is also the view of business partners, customers, shareholders, and the general public. A great deal of trust is invested in WACKER.”

For the survey, the Statista analysts defined four criteria that determine a company’s reputation: trustworthiness, social action, the company’s behavior as an employer, and the quality of the product or service. Four of the ten best firms and organizations were chemical and pharmaceutical companies. Ahead of WACKER, in places one to three, were Deutsche Bundesbank (the central bank of Germany) and the consumer goods manufacturers Lindt & Sprüngli and Weleda.

WACKER AT TRADESHOWS

in-cosmetics global
Paris, France
April 2-4, 2019
www.in-cosmetics.com/global

BATTERY SHOW
Stuttgart, Germany
May 7-9, 2019
www.thebatteryshow.eu

Techtextil
Frankfurt am Main, Germany
May 14-19, 2019
techtextil.messefrankfurt.com

EWMA
Gothenburg, Sweden
June 5-7, 2019
ewma.org/ewma-conference/2019

LABEL EXPO
Brussels, Belgium
September 24-27, 2019
www.labelexpo-europe.com

Abrafati
São Paulo, Brazil
October 1-3, 2019
www.abrafati.com.br/eventos/abrafati-2019

K
Düsseldorf, Germany
October 16-23, 2019
www.k-online.de

SILRES® BS 6921 is a new silane-based binder which, thanks to its adhesive strength and flexibility, is suitable for formulating flexible, stain-resistant anti-soiling coatings for concrete, epoxy and polyurethane floors and for producing stone carpets and pervious systems.

NEW FLEXIBLE BINDER FOR PROTECTING MINERAL-BASED FLOORS

WACKER will be unveiling a new silane-based binder, SILRES® BS 6921, at the 2019 European Coatings Show

Like its predecessor SILRES® BS 6920, SILRES® BS 6921 is based on alpha-silane technology. The new grade, however, is much softer than the original version. The low-viscosity alpha-silane-terminated polyether cures rapidly upon contact with atmospheric moisture to yield a comparatively soft, flexible coating that affords outstanding protection against soiling and staining.

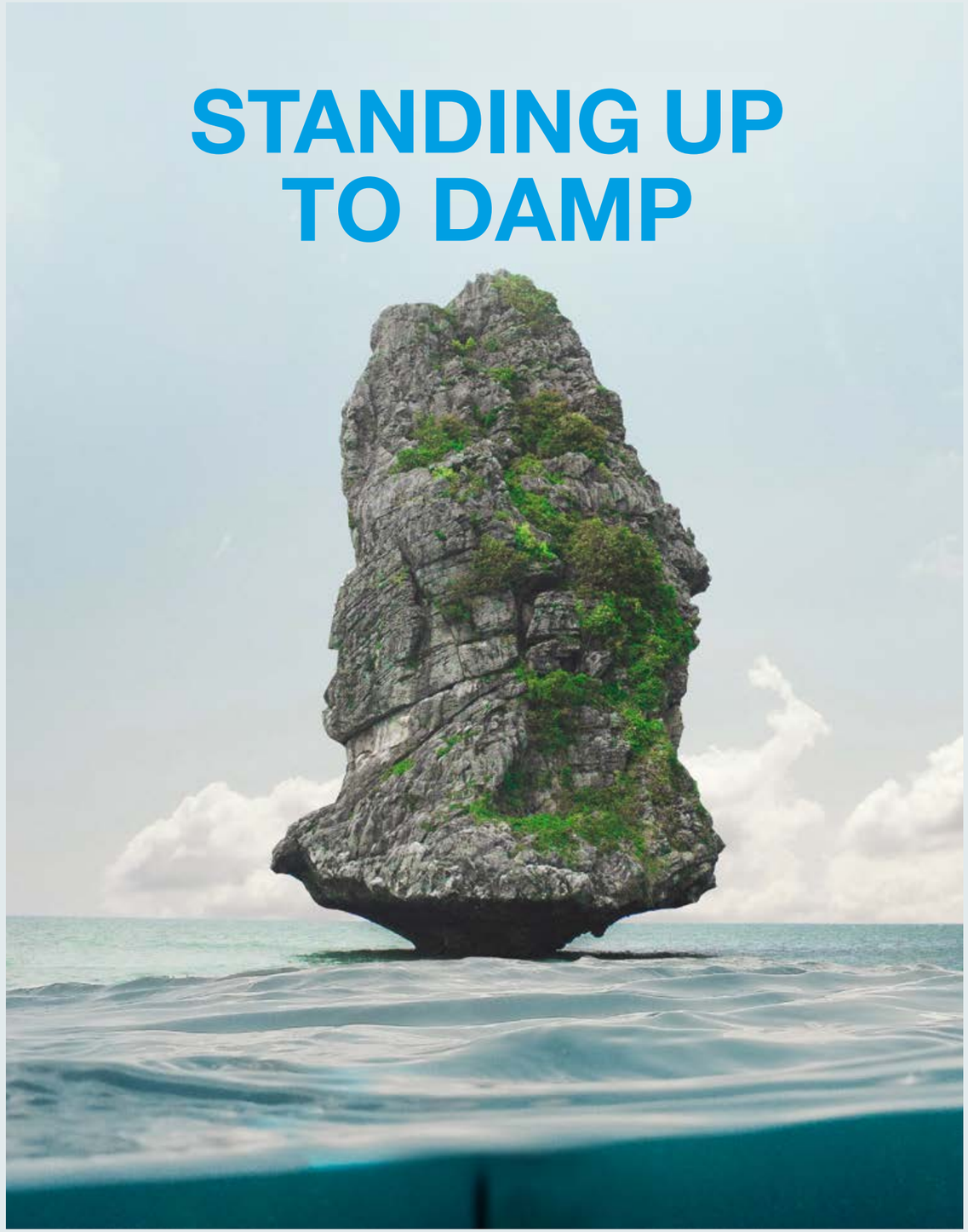
The main purpose of the new binder is to flexibilize the chemically related SILRES® BS 6920, which is already being used for transparent, extremely hard-wearing concrete floors but which is too brittle for use with flexible substrates. Its hardness creates a risk of cracking should the floor experience mechanical stress or deform in response to large temperature fluctuations.

With SILRES® BS 6921, it is now possible to formulate much more flexible coatings that can also withstand thermal expansion and mechanical deformation. Tests show that 20% to 30% SILRES® BS 6921 is enough to adapt the binder to the properties of the intended substrate. Such formulations bond very strongly not only to cementitious floors but also to epoxy and polyurethane substrates. The bond is in fact so strong that the formulations are suitable for manufacturing repair sets for damaged epoxy or polyurethane flooring, pervious systems and stone carpets. SILRES® BS 6921 is a crystal-clear formulation and remains transparent after curing. Yellowing induced by exposure to the sun or other light sources is reliably prevented by the addition of light stabilizers.

The binder combination is formulated to yield one-part end products which can be applied with a mop, roller or spray gun. The coating is generally applied in two thin layers, at an average rate of some 100 grams per square meter. The first layer strengthens the floor, while the second produces a more homogeneous finish that increases stain, scratch and scrub resistance and makes the floor polishable.

Coatings based on blends of SILRES® BS 6921 and SILRES® BS 6920 are as equally at home in parking garages, auto repair shops, railroad station buildings and logistics centers as they are in display and sales rooms, restaurants, arenas for events and exhibitions, museums and private dwellings. The treated floor is easier to maintain and stain resistant as a result of the treatment. Abraded material, dirt and liquid spills can be removed with ease.

STANDING UP TO DAMP



Waterproofing membranes ensure that unwelcome damp does not penetrate through floors and walls. But as they have a high polymer content of up to 30% and are applied in layers just two millimeters thick, they are not that easy to process. In VINNAPAS® 7150 E, WACKER has now launched a dispersible polymer powder for formulating waterproofing membranes that possess better non-slump properties and are easier to handle.

Canals and wastewater sewers are typical applications in which waterproofing membranes ensure that moisture does not seep into the ground.

Don't go any further! Waterproofing membranes deal with unwanted damp in the same way as bouncers treat unwelcome guests. The barrier layers step in to prevent damp from causing any trouble inside or outside a house. Waterproofing membranes provide basement walls, terraces, and bathrooms with a thin layer of protection which nonetheless keeps out penetrating water that might otherwise damage the building fabric and cause mold. "Swimming pools and water tanks also need these kinds of cementitious mortar barriers," says Dr. Hardy Herold, head of a technical laboratory for construction applications at WACKER POLYMERS. The sealing layers are applied direct to the surfaces needing protection. They can then be covered with other, appropriate materials, such as tile adhesives and tiles in wet rooms, and bituminous sheets on flat roofs.

"The improved non-slump properties now make it easier to use notched trowels to apply waterproofing membranes."

Dr. Hardy Herold, Lab Manager, WACKER POLYMERS

In southern Europe, builders prefer brushes to apply waterproofing membranes, whereas in German-speaking countries, they tend to favor notched plastering trowels.

USING A PLASTERING TROWEL

The tools that tilers use to apply these membranes vary across Europe. In southern Europe, they prefer brushes, whereas in German-speaking countries they tend to favor notched plastering trowels. The latter may have notches measuring four millimeters in length. "In the tilers' hands, these produce a uniform layer of waterproofing membrane with narrow ridges of precisely that height," explains Herold. "The tilers then smooth the membrane surface with the other, smooth side of the trowel." This step ensures that the layer has the necessary two millimeters' thickness required by German "PG-MDS" waterproofing-membrane standards.

However, the desired results can only be achieved in practice if the waterproofing membrane possesses the optimum properties. The key to success here is its rheology or flow characteristics. The rheology determines the degree of slump in the cement mortar, i.e. whether the ridges remain standing or collapse. As binders that make up as much as 30% of a waterproofing membrane, dispersible polymer powders play a lead role here.

The polymer-modified dry-mix mortar is redispersed with water at WACKER's applications laboratory.

The waterproofing membrane is applied to a concrete test piece as per EN 1062-7.

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"Satisfactory non-slump properties were hard to achieve with our existing product portfolio," says Herold. "The binders are eminently suitable for brushable waterproofing membranes, though, which are less demanding in this regard. But for German-speaking countries, where trowels are the main application tool, the dispersible polymer powders proved unsuitable." To open up this market, Herold's team needed to impart better non-slump properties to the WACKER products. So, they set about modifying the formulation for the dispersible polymer powders and ended up developing a new product: VINNAPAS® 7150 E. The binder which the construction chemical experts created offers enhanced rheological properties for waterproofing membranes.

For the base polymer, they opted for a tried-and-true product, namely VINNAPAS® 7055 E. It consists of a combination of vinyl acetate-ethylene polymers and vinyl esters. "We originally tried

“As time passes and minor cracks start to appear in plaster or masonry, it is important that the sealing compounds do not fail. And it is the relatively high content of dispersible polymer powder which ensures that this objective is met. It not only acts as a waterproofing agent, but also makes the layer flexible.”

Dr. Hardy Herold, Lab Manager, WACKER POLYMERS

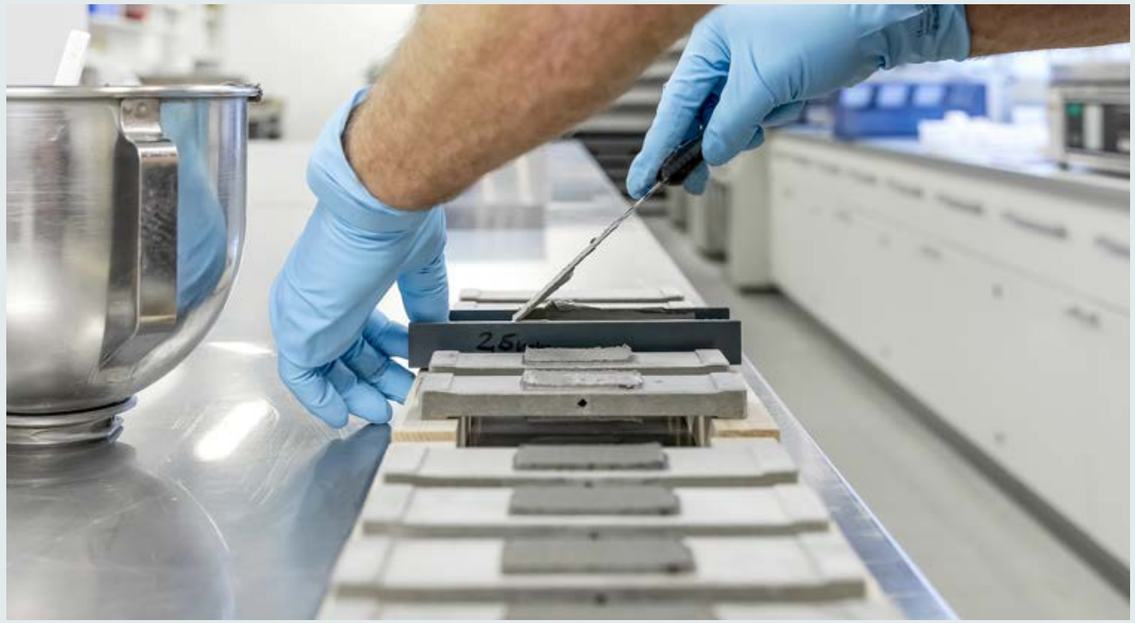
to boost the non-slump properties of the compound by incorporating additional thickeners. But that didn’t work,” says Herold. “We eventually hit upon using newly developed protective colloids and silica particles, and they worked a treat,” he added. “Thanks to the modifications, when the dispersion is spray-dried, it yields a powder which contributes much more rheological stability and increased non-slump in the end product.”

GOOD CRACK-BRIDGING

A further bonus is that the waterproofing membrane is not as tacky. This greatly benefits processing, because the paste-like compound clings less to the trowel and more to where it belongs – on walls or floors. This is a huge advantage for meeting the two-millimeter requirement because waterproofing membranes have to accomplish a number of tasks. One of them is crack bridging – which the binders play a large role in. According to Herold, “As time passes and minor cracks start to appear in plaster or masonry, it is important that the sealing compounds do not fail. And it is the relatively high content of dispersible polymer powder which ensures that this objective is met. It not only acts as a waterproofing agent, but also makes the layer flexible. This prevents cracks from spreading from the substrate to the surface and acting as a conduit for moisture to penetrate.”

The test for this property involves bending a concrete slab coated with the sealing compound until a 0.4-millimeter crack appears. The

To perform the crack-bridging test as per EN 1062-7, the waterproofing membrane is spread to a defined film thickness.

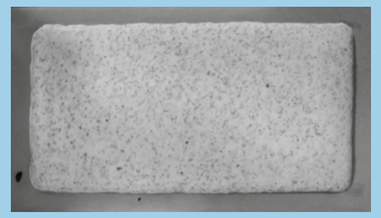


Preparing samples for testing crack-bridging as per EN 14891.

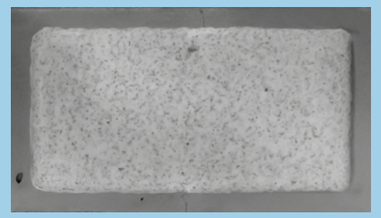
A lab technician tests the deflection of the concrete test piece as per EN 1062-7. This standard stipulates that cracks must not exceed a width of 0.4 millimeters.

slab is kept under tension for 24 hours. If no hole appears in the protective layer, the product complies with the EU's Construction Products Regulation, ETAG 022. This demanding test is passed by waterproofing membranes treated with VINNAPAS® 7150 E. "Our dispersible polymer powders manage to perform quite a balancing act," explains Herold. "They hold all the particles together in the intact polymer film while bestowing the necessary flexibility on the matrix." What is more, by virtue of their low glass

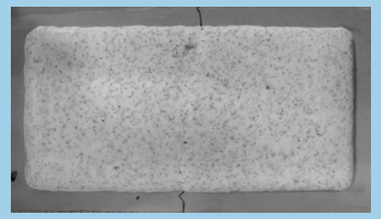
CRACK-PROPAGATION TEST AS PER EN 14891



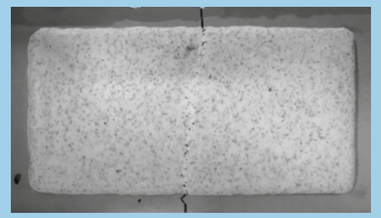
Intact test piece before testing



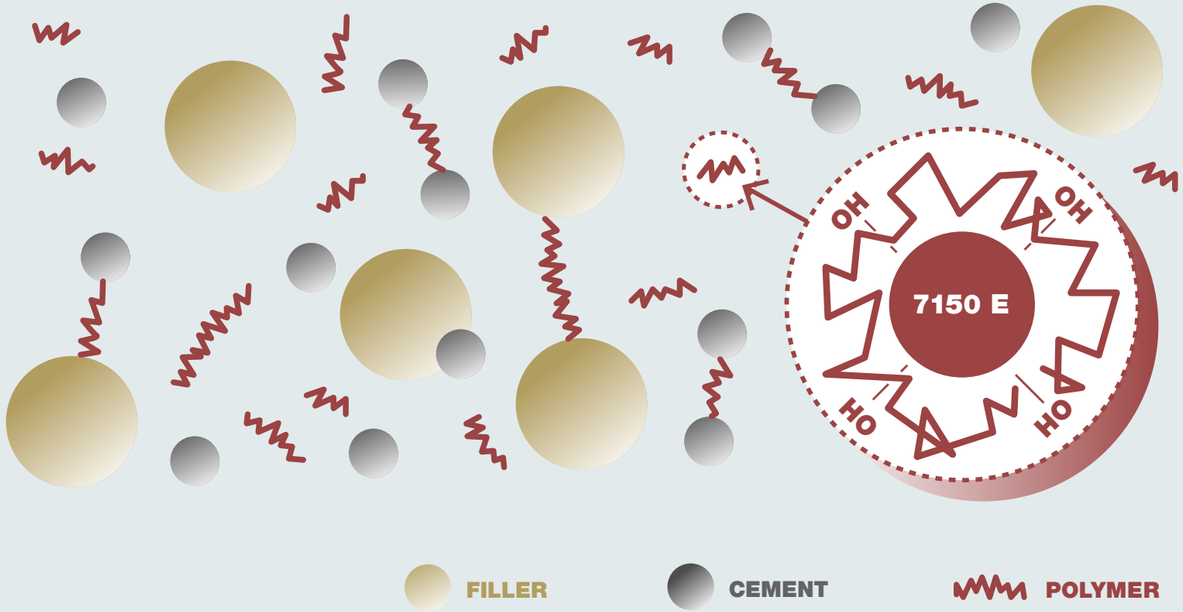
Gradually increasing the size of the crack at a defined tensile testing rate

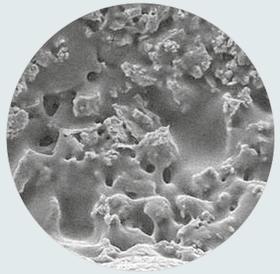


Pulling the test piece apart further



The width of the crack when the first flaw occurs in the protective layer represents crack-bridging in mm.





MODE OF ACTION OF POLYMER PARTICLES IN A WATERPROOFING MEMBRANE

The special protective colloid of VINNAPAS® 7150 E enables the polymer to interact to optimum effect with the binder, fillers and other additives making up the waterproofing membrane. As a result, once the membrane has set, VINNAPAS® 7150 E forms a closed network of polymer films. It is this network that optimally bonds all the mortar constituents.

transition temperature, waterproofing membranes containing the new WACKER binder can bridge cracks at temperatures as low as 5 °C, as determined in accordance with EN 14891.

The dispersible polymer powders provide a further advantage: VINNAPAS® 7150 E does not contain any solvents, plasticizers or film-forming agents and so it does not emit any harmful substances, such as volatile organic compounds (VOCs) – consequently the binders have attained EMICODE® EC1 status, which is reserved for products that have very low emissions and meet the most stringent environmental and health requirements. "Our binder has even been approved by the German Federal Institute for Risk Assessment for the drinking-water sector," says Herold. All these talents displayed by the gossamer-thin protective barriers are in addition to their main task of keeping out penetrating water. The WACKER expert cites an impressive figure to confirm that they do just that: waterproofing membranes have to withstand water pressure at 1.5 bar. That is the equivalent of a water column 15 meters high. The two-millimeter-thick layers meet this challenge with ease, ensuring that houses come to no harm.

And thanks to the improved non-slump properties, construction workers in Germany, Austria and Switzerland, with their preference to use trowels, can now reap the benefits of the new high-performance dispersible polymer powders. ■

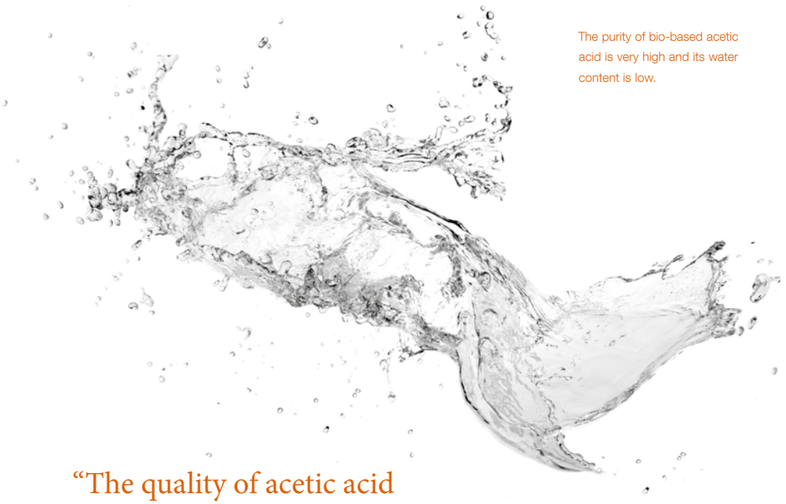
BASED ON RENEWABLES

Ecological, sustainable building is one of the major trends in the construction industry. With the market launch of VINNECO®, WACKER has introduced a line of binder products based partly on renewable raw materials. The new VAE dispersions are produced via two manufacturing processes – one using bio-acetic acid and the other potato starch.

rom private home builders to architects on large-scale projects – for more and more property developers, the use of environmentally friendly construction materials plays an important role. Recognizing this market potential, the industry has been looking for alternatives to fossil resources for some time now. "The trend toward biobased products has caught up with interior paints too," says Dr. Lada Bemert, a senior technical service manager at WACKER POLYMERS. Market figures back up that claim: in 2017, biobased paints and coatings generated US$1.14 billion in sales in Europe and the US according to a study entitled "Growth Opportunities for Bio-Based Chemicals and Materials in Europe and North America, 2017" conducted by the Frost & Sullivan consulting company. And that upward trend is likely to continue: given its average annual growth rate of 4.3%, market researchers expect the market for biobased paints and coatings to grow to a volume of US$1.52 billion by 2024.

"Our customers are increasingly looking for alternatives to fossil feedstocks as well," Bemert notes. "We've updated our processes accordingly and our use of renewable raw materials is taking dispersion manufacturing in a new direction." There are two methods for producing binders based on renewable resources, and the Munich chemical group will market these binders under the VINNECO® product line. WACKER will be unveiling five products at the 2019 European Coatings Show in Nuremberg.

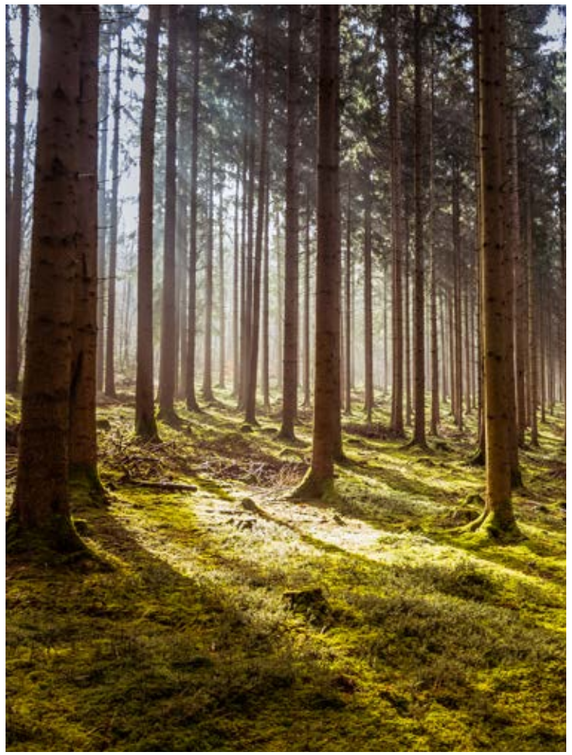
The use of wood as a resource in the first production method proved to be a good choice: "Our polymers are based on acetic acid sourced from the wood-processing industry," says Dr. Martin Schierhorn, a chemist and marketing manager at WACKER POLYMERS. "The compound is formed as a byproduct of wood-industry processes such as preparing fibrous material for paper manufacturing. You don't have to chop down a tree, in other words, to make acetic acid from it." The wood is sourced from PEFC™-certified forests located within a 400-km radius of WACKER's Burghausen site. PEFC, which stands for Programme for the Endorsement of Forest Certification Schemes, is a certification system for sustainable forest management. PEFC standards govern practices such as reforestation, securing habitats and biodiversity, and protecting soil, water and the climate.



The purity of bio-based acetic acid is very high and its water content is low.

"The quality of acetic acid obtained from renewable raw materials is very high."

Dr. Lada Bemert, Senior Technical Service Manager, WACKER POLYMERS



When used in wall paints, WACKER's polymer dispersions ensure that pigments, fillers and additives are held together and that the paint adheres to the wall to optimum and durable effect.

BIO-ACETIC ACID

WACKER uses ethylene and the bio-acetic acid obtained in this way to produce vinyl acetate monomer, which – again using ethylene – is copolymerized to form vinyl acetate-ethylene (VAE). The binders are polymer dispersions that, in the example of wall paint, hold pigments, fillers and additives together and ensure optimum, lasting adhesion of the paint to the wall. No aspects of either the binders or the wall paints suggest whether the VAE they contain was produced from conventional or from biobased acetic acid. The compound always exhibits the same chemical and physical behavior, regardless of whether it was derived from fossil-based or renewable raw materials.

"In studies, we were able to demonstrate that acetic acid from renewable raw materials meets our quality requirements in every respect. Its purity is very high and its water content is low," Bemert explains. "That's why bio-acetic acid represents a real alternative to its counterpart based on fossil feedstocks like natural gas or crude oil. By blending it in with traditional acetic acid, we can directly couple it to our existing VAE production line," the chemist points out.

This allows paint manufacturers to keep their existing formulations without having to adjust them in any way for their plasters or wall paints. "But that also means that not even our customers can tell whether the bind-

PEFC™

PEFC standards govern practices such as reforestation, securing habitats and biodiversity, and protecting soil, water and the climate.

ers we deliver are derived from fossil-based or biobased acetic acid," Bemert adds.

BIOMASS BALANCE METHOD

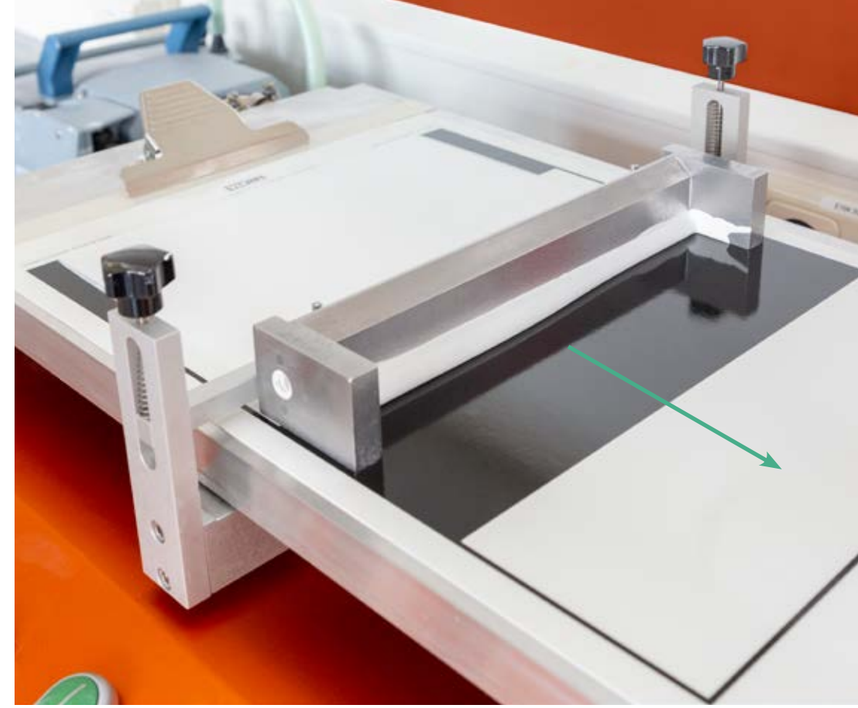
To verify the biobased component and demonstrate this to its customers, WACKER uses the biomass balance method. This approach allows the company to calculate how much of a VAE dispersion was produced from renewable raw materials. The method, which WACKER is applying for the first time in vinyl acetate-ethylene production, has been certified by the TÜV SÜD international technical inspectorate in accordance with the global CMS 71 standard. As Bemert explains, "When customers order from the new VINNECO® product line, they can be sure that the required amount of bio-acetic acid has been fed into the integrated production system." As verification, the customer receives a TÜV certificate attesting to the use of the renewable raw material. For the customer, this means that sustainable versions of the products in the VINNAPAS® family, which remains a well-known, classic brand, are now available under the new VINNECO® brand. At the 2019 European Coatings Show, WACKER will be introducing four specific products suitable for use as binders in plasters and paints (see box on page 27). For the moment, only a relatively small percentage of WACKER's global output of VAE dispersions is based on renewable resources. The biomass balance approach, however, will allow the company to adjust those amounts going forward. In addition to its new binders for interior paints and plasters, WACKER offers biomass-balance versions of other product lines, such as vinyl acetate homopolymer dispersions and solid resins based on vinyl acetate.

At WACKER's applications laboratory, tests are performed on the hiding power of paint modified with the new polymer/starch hybrid binder.

STARCH-BASED PRODUCTION

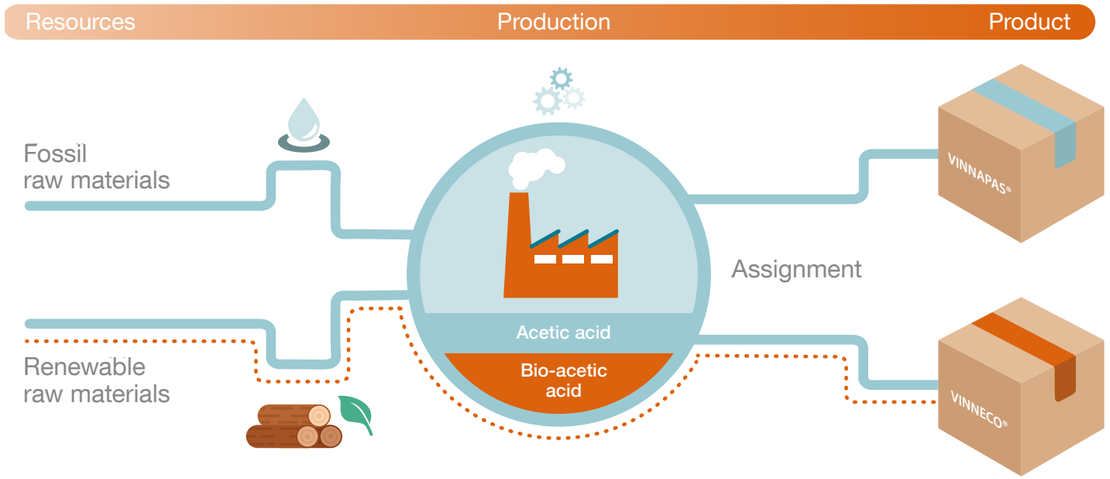
WACKER takes a much different approach for the second binder production method, cooperating with Dynaplak, a Dutch company that manufactures biobased raw materials. The material in this case is starch, which exhibits the properties of a binder when emulsified. This natural polymer is a side-stream product of potato processing. Experts at Dynaplak use this starch, which would otherwise be lost, and modify it with an innovative technology to improve its performance. "Even though natural starch has been known as a binder for millennia, it isn't really the best for modern industrial applications. We take the enhanced form from Dynaplak and combine it with our vinyl acetate-ethylene polymers to form a new hybrid binder," Bemert explains. The modified biopolymer accounts for 30% of the new product. This reduction in the amount of traditional VAE derived from fossil-based raw materials yields a lower carbon footprint in the resulting product.

The result is a high-performance binder that WACKER will be marketing under the name VINNECO® CT 7030. As Schierhorn says, "Our new, hybrid product makes us one of the first companies on the market to combine vinyl acetate-ethylene polymers with starch for industrial applications. We've maximized the proportion of starch as much as we can. When it comes to rheological properties, wet-scrub resistance, dispersibility and hiding power, VINNECO® CT 7030 can hold its own with traditional products made from fossil feedstocks. Because this is a new product with its own property profile, however, paint manufacturers may need to update their formulations under certain



To test its hiding power, the paint is spread evenly over a black substrate. The contrast ratio is then measured.

When directly compared with conventional wall paint, the good hiding power of paint modified with VINNECO® CT 7030 is confirmed.



Balance of the starting materials used has been inspected and certified by TÜV SÜD

THE BIOMASS BALANCE METHOD

If raw materials from renewable and traditional – usually fossil-based – resources are used as starting materials within the same integrated production system, the biomass balance approach can be used for mathematically assigning the portion of renewable raw materials to individual sales products. Fossil feedstocks are then mathematically assigned to the production of all other sales products. The approach is comparable to the green electricity certification system used in Germany.

The international TÜV SÜD technical inspectorate has certified WACKER's mass balance method for verifying renewable raw materials in production. This gives WACKER a recognized method for tracking its use of renewable resources throughout the entire production process, up to the finished product. To qualify, suppliers of renewables must use a sustainable manufacturing process for the raw materials that WACKER purchases, and all of the required starting materials must be obtained from sustainable sources as well. WACKER must also undergo an annual TÜV inspection to verify that the appropriate amount of renewable raw materials is always added during the production of declared products.

circumstances. The advantage is that the starch polymer allows them to directly utilize biomass in the finished product. Schierhorn went on to point out that the biological component of VINNECO® CT 7030 could for example be verified by means of the carbon-dating method, which is used for verifying the age of fossils, among other applications. That this new product will not be an isolated case is likewise certain: "Demand for alternatives based on renewable raw materials is growing, especially for interior paints," Schierhorn says. "That's why we're working with Dynaplak to develop a wide selection of hybrid binders."

Prospects for the new VINNECO® product line are good, in other words – and they confirm WACKER's commitment to sustainability. "The VINNECO® brand is an additional product line for us, and we will be introducing specific products both at the European Coatings Show as well as throughout 2019," says Schierhorn. "This has been an initial, important step toward using renewable raw materials in the production of our binders. And we will continue to look into more methods for reducing fossil feedstocks." ■

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AN OVERVIEW OF THE FIVE VINNECO® PRODUCTS

VINNECO® products based on the biomass balance method can be identified by the abbreviation MB in their names. These are each available in two grades, in which either 60% or 100% of the fossil feedstocks have been replaced with bio-acetic acid.

VINNECO® EP 3360 (60MB)

Proportion of fossil feedstock replaced: 60%
Properties: aqueous polymer dispersion composed of vinyl acetate and ethylene, with a solids content of ~60%
Application areas: dispersion-based interior wall paints and plasters

VINNECO® EP 3360 (100MB)

Proportion of fossil feedstock replaced: 100%
Properties: aqueous polymer dispersion composed of vinyl acetate and ethylene, with a solids content of ~60%
Application areas: dispersion-based interior wall paints and plasters

VINNECO® EF 3777 (60MB)

Proportion of fossil feedstock replaced: 60%
Properties: aqueous polymer dispersion composed of vinyl acetate and ethylene, with a solids content of ~56%
Application areas: dispersion-based interior wall paints and plasters

VINNECO® EF 3777 (100MB)

Proportion of fossil feedstock replaced: 100%
Properties: aqueous polymer dispersion composed of vinyl acetate and ethylene, with a solids content of ~56%
Application areas: dispersion-based interior wall paints and plasters

VINNECO® products based on starch for paint applications can be identified by the abbreviation CT in their names.

VINNECO® CT 7030

Properties: aqueous polymer dispersion composed of vinyl acetate, ethylene and modified starch, with a solids content of ~47%
Application areas: interior wall paints

A BETTER BARRIER

With VINNEVA®, WACKER is launching a new product line for polymer-modified bitumen emulsions. The VAE polymers ensure that coatings adhere exceptionally well to the building fabric for a long time and offer better protection from the ingress of water.

In Europe and North America, the dark, semisolid, high-molecular mixture of different hydrocarbons known as bitumen is usually modified with polymers.

Bitumen can be found virtually everywhere. We walk on it every day – it is the binder in asphalt. A bitumen coating can protect basement walls, for instance, from the ingress of water. Even in ancient times, bitumen served to seal flat roofs – such structures were used in the Hanging Gardens of Babylon, one of the Seven Wonders of the World, for example.

Today, bitumen is no longer obtained as a mineral pitch from wells as it was in ancient Babylon, but is rather found in refineries as a residue in the vacuum distillation of petroleum. In Europe and North America, this dark, semisolid, high-molecular mixture of different hydrocarbons is usually modified with polymers that enhance its property profile. In other regions of the world, bituminous substances are still predominantly used without polymeric additives. Nevertheless, the market for polymer-modified bitumen is growing. According to a study by Global Market Insights, the sector generated sales totaling some US$9.5 billion in 2016. Market researchers are expecting average annual growth rates of 4% until 2024.

WACKER has developed binders based on vinyl acetate-ethylene (VAE) copolymers specifically for bitumen emulsions and is marketing them under its VINNEVA® trade name. On the one hand, the product line is intended to convince users of non-modified bitumen emulsions of the benefits of a polymer additive – this makes the coatings more flexible and more resistant to all kinds of mechanical stress. On the other hand, VINNEVA® offers several advantages over competitor products that have been used in bitumen emulsions to date. These are mainly elastomers, i.e. rubber-like substances, such as styrene-butadiene rubber (SBR) and polychloroprenes.

EXCELLENT ADHESION

“A content of several percent of VINNEVA® – depending on the formulation – is enough to increase the performance of bitumen tremendously and advance it to the Champions League of water-repellent building gcoatings, so to speak,” emphasizes Dr. Markus Busold, head of Strategic Marketing for Consumer & Industrial Polymers at WACKER. He explained that VINNEVA® modified formulations outperform other modified bitumen emulsions, especially

Bitumen coatings protect floor panels and flat roofs from the ingress of water.

Builders use polymer-modified bitumen to seal basement walls watertight.

when it comes to tensile adhesion strength and their barrier effect against water. Extensive tests at WACKER's applications laboratories have shown that the tensile adhesion strength increases by up to 60% compared to conventionally modified bitumen emulsions.

In order to test tensile adhesion strength, the lab team first applies the bitumen emulsion to a concrete slab. Once it has dried, they cut circular test areas into the coated slab, sticking a metal test piece onto each one of these areas. They then measure the force required to peel off the test pieces, including the bitumen coating sticking to them, from the concrete. The higher the necessary force, the more difficult it is to detach the coatings from the building fabric, i.e. the stronger their adhesion to it.

MORE RESISTANCE TO WATER PRESSURE

A bitumen coating's most important function is to protect basements, roofs or entire buildings from the ingress of water. To test how well a coating fulfills this function, WACKER technicians apply it to small concrete cubes and allow it to dry under defined climatic conditions. In a special facility, they then expose the coated cubes to an adjustable water pressure for 24 hours, for instance. After this time, they measure whether any of the originally used water has been "lost" due to ingress into the concrete cube. "Our tests have demonstrated that bitumen emulsions that have VINNEVA® added to them can withstand higher pressure than coatings modified with conventional polymers," explains Busold.

"An amount of several percent of VINNEVA® is enough to increase the performance of bitumen tremendously and advance it to the Champions League of water-repellent building coatings, so to speak."

Dr. Markus Busold, Senior Manager, Strategic Marketing for Consumer & Industrial Polymers

This kind of perimeter insulation, which includes the floor panel, stops damp from forming in the basement and prevents a house from cooling down from below.

Styrofoam or other foamed plastic insulation panels are placed on the bitumen barrier layer to provide the basement wall with insulation against energy loss.

There are further properties that characterize VINNEVA® modified bitumen emulsions. A sample formulation took 3.5 hours to dry, for example. When the VINNEVA® component was replaced with another additive – with the formulation otherwise the same – the drying process took 4.5 hours. What's more, the dried coatings based on the new polymer are less sticky than various other systems. In many cases, shorter drying times represent increased productivity for end customers, which can lead to cost savings in applying the bitumen emulsion.

TWO APPROACHES TO MODIFICATION

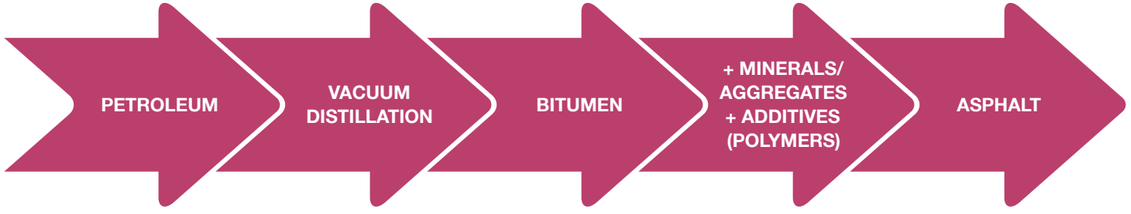
It must always be taken into account that the properties of a bitumen emulsion do not just depend on the polymers used, but also on the bitumen composition and other additives. Bitumen is a mixture of heterocycles, polycyclic aromatic hydrocarbons, and branched hydrocarbons with varying degrees of saturation. Depending on where the crude oil is sourced, the proportion of these compounds in bitumen varies greatly.

Coatings are based on bitumen emulsions that can be produced in colloid mills from hot bitumen and water that contains additives. There are two ways of modifying bitumen coatings with a VINNEVA® polymer: the polymer is either added to the water jet before the emulsion forms or to the bitumen emulsion at the end.

This is why, for its customers, WACKER individually tailors its VINNEVA® polymers to the bitumen composition and additives. Experts

WHAT IS ASPHALT?

Schematic depiction of petroleum-based bitumen production.
Bitumen can also be made from natural gas.



The best known and most common use of bitumen is as asphalt in road surfacing. For this purpose, residue from the distillation of petroleum (in very rare cases, natural gas) is processed with aggregates and polymeric additives under pressure and with exposure to heat.

at the Group's application technology centers, which are located in all key markets, provide support here. Thanks to this local presence, it is possible to formulate coatings that are superior to products based on other polymers with regard to key properties such as elasticity, elongation at break and watertightness.

VINNEVA® polymers are not only based on petroleum, but also on natural gas. "Thanks to this diversified raw-material base, their price fluctuates less in the long term than that of other polymers used for bitumen modification," says Busold. In addition, unlike some other additives, they do not contain chlorine.

VINNEVA® polymers can also enhance fiber-reinforced or filled bitumen coatings. Plus, the polymers are ideal for optimizing two-component systems, which are particularly popular in Europe. These consist of a liquid component – the polymer-modified bitumen emulsion – and a powder-form component made of cement and fillers. They can be applied in particularly thick layers. ■

Most of the bitumen left after the distillation of petroleum is used as asphalt in road construction.

Tests being performed at WACKER's applications laboratories.

Top left: Thanks to polymer modification, tensile adhesion strength rose by as much as 60% compared to conventional bitumen emulsions.

Top right: Low-temperature flexibility is tested in a climatic chamber.

Right: Examining crack-bridging. When exposed to stress, the polymer-modified bitumen emulsion has to endure cracks in the concrete substrate.

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ADHESIVE STRENGTH MEETS FLEXIBILITY

Large-format tiles are currently popular in bathrooms. Affixing them properly to walls or floors requires not just good tiling skills, but also the right adhesive. The polymeric binders supplied by WACKER enable adhesive manufacturers and users to meet this challenge.

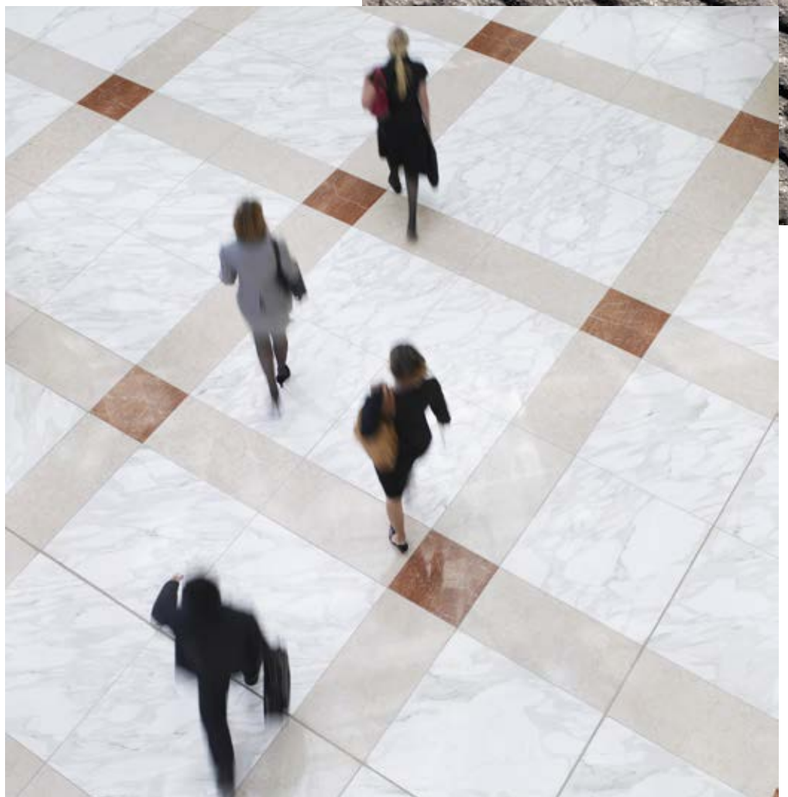
Bathrooms nowadays are much more than purely functional wet rooms. According to "Schöner Wohnen," a German home decoration magazine, "feel-good bathrooms" and "personal spas" are right on trend. Especially for those who have the funds and feel drawn to a classy modern look. "The bathroom is second only to the kitchen in terms of greatest financial outlay," says Dr. Tobias Halbach, director of Technology Management for Construction Polymers at WACKER. "We spend an average of 45 minutes every day in the bathroom, so it should be a well-appointed, welcoming space. Functionality, design and wellness aspects are becoming more important all the time."

Whether new build or renovation, whether modern, traditional or Mediterranean style – the world is your oyster when it comes to a fit-out. The style is particularly affected by the choice of wall and floor coverings. "All around the world, it is the major manufacturers who determine what is the latest fashion in tiles," says Halbach. "They set global trends – regional tastes are actually rare." The WACKER expert also knows the most popular type of tile among consumers in the developed industrial nations: large-format tiles, measuring at least 60 x 60 centimeters. "These look particularly classy, make rooms seem larger and are also more pleasant to walk on because there are fewer joints between them.

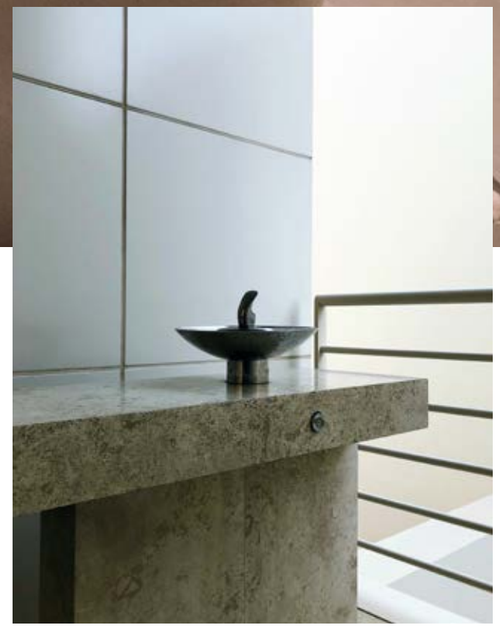
Not only that, but large-format tiles are also easier to clean because of those fewer joints. People are falling in love with large-format tiles not only in Europe, but virtually everywhere else. It wasn't always like that. Bathrooms in the 1970s featured dark tiles with floral motifs. These gave way in the 1990s to bright tiles with colorful borders. Then, over the past 15 years, larger and larger porcelain tiles gradually gained in popularity. For several years now, unusual motifs, such as a wood or concrete look, have been conquering the market. High-resolution digital printers are capable of printing a huge range of decorative motifs and textures straight onto the porcelain.

A CHALLENGING TREND

The shape, size and constituent material of the tiles dictate the tiling method, the conditions



Room for a creative vibe and a feel-good factor: large-format tiles not only look elegant, but also give the appearance of space.



"It is the major manufacturers that set tile trends around the world."

Dr. Tobias Halbach, Director of Technology Management

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“GREATER CRAFTSMANSHIP NEEDED”

Master tiler Markus Ramrath talks about the challenges of laying large-format tiles.

Markus Ramrath, master tiler and stonemason from Korschenbroich in North-Rhine Westphalia, is an acknowledged expert in his field and a member of the German Tiles and Natural Stone Technical Association (FFN).

What are the challenges involved in laying large-format tiles?
Markus Ramrath: Large formats have edge lengths of 60 to 120 centimeters. Whoever opts for them must reckon on long installation times. This starts with the preparation time, because the substrates need to be very level when large tiles are used. Otherwise, stresses will more easily build up later that can lead to cracks and breaks in the tile. For aesthetic reasons, the joints between the tiles are usually narrow and allow little margin for error or adjustment afterwards. The tiler therefore has to work extremely accurately. The drying times are also longer because the water released from the adhesive during setting has a harder job finding its way out. There are only a few joints, after all, and they are usually narrow. It is important to employ specialty tile adhesives with crystalline water-binding capacity and an increased proportion of polymer to facilitate better curing. Otherwise, there is a greater risk of stresses and breaks were, e.g., objects to fall onto the tiles. Also, tilers need more time to prepare the tiles properly for the room, i.e. to cut them to size and to create holes for fittings and connections.

Which rooms lend themselves to such large tiles?
They are very good for walls, as there is much less stress on the tiles there. That makes the work of the tiler easier. For flooring in a domestic setting, the large formats are also suitable because the load is manageable. Fitting out car dealerships or large canteens with them would be a different case entirely. Those call for particular experience and skill on the part of the tiler. This also applies to any damage and repairs, because the size of the tiles and the narrow joints make them very difficult to remove and replace. Added to which, the tiles are becoming not only larger, but also thinner.

How do you see this trend?
As far as the extra-large formats are concerned, i.e. tiles with edge lengths greater than 1.20 meters, myself and other FFN experts are still very much in the process of learning all about them. Ultimately, what we find out is purely the result of the damage that occurs in practice. We use this to produce specialized information leaflets in which we address the risks and provide advice on how to use extra-large tiles. This work will go on for several more years, though. The extra-large tiles, for example, need up to four people to press them down and a support frame to ensure the ceramic doesn’t break during transport. Finally, we tilers are attempting to adapt our working techniques accordingly. What always has to be borne in mind is that the rooms where the work is done are not constructed to laboratory standards. We have to get the best-possible results from the situation at hand. The tile adhesive manufacturers, too, are adapting their recipes to whatever the tile producers bring to market. There are always new challenges from which we experts learn a lot.

Have you any interesting examples?
We had one case where the tiles could not be laid with any of the usual adhesives. Nothing would stick to the reverse side of the ceramic – not even epoxy resin. In another case, a restaurant floor was covered in tiles three millimeters thick. It only took one knife to fall on it and cracks appeared everywhere. However, such damage scenarios help us in the FFN to collate the optimum basic conditions for the laying of large-format tiles – so that such mistakes are not repeated in the future.

WWW 1.19 ▸ SOLUTIONS ▸ **TILE ADHESIVES**

which the substrate must meet and the choice of adhesive to use.

“Large formats are generally harder to handle,” says Armin Hoffmann, a senior technical manager at WACKER. “They are heavier and once they reach a certain weight need two people to carry them. That makes tiling a much more complicated process.” For a start, the walls or floor need assiduous preparation and must be level. “Any irregularity whatsoever in the substrate can put a tile under stress further down the line. And the larger the tile, the greater the risk that it will break,” explains Hoffmann. Large-format tiles are correspondingly more expensive to repair than smaller ones.

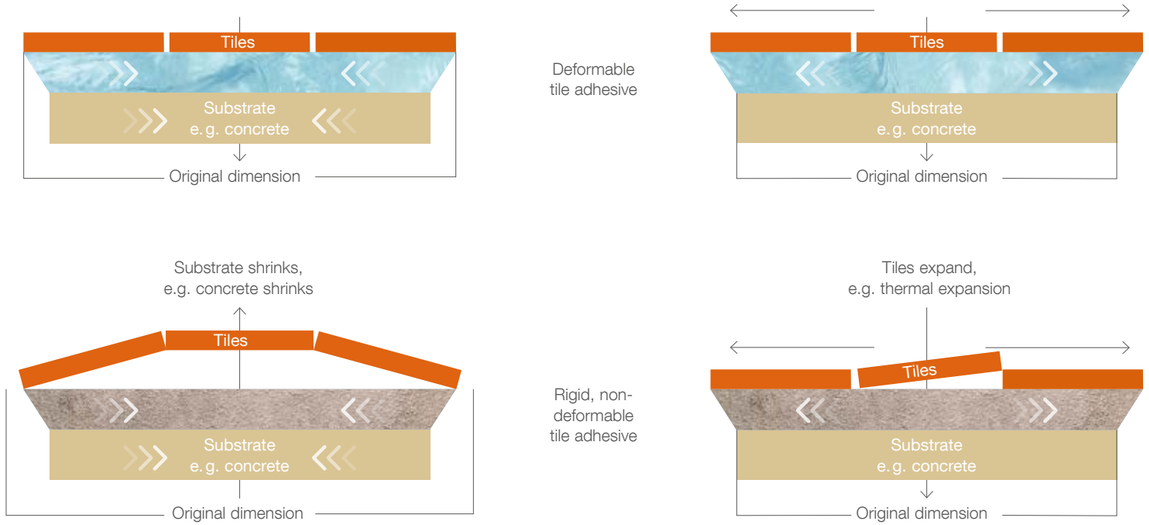
Expert handling is therefore just as essential as the right choice of tile adhesive. Binders play a key role in an adhesive, because they boost the bond between the tile and the substrate while also increasing the adhesive’s flexibility. The latter is especially important for very thin tiles just three millimeters thick. These may weigh less in large format, but they are also difficult to handle. “Thin tiles simply break more easily and need to be transported very carefully,” explains Halbach.

But even when they are firmly attached to a wall or floor, thin, modern large-format tiles can still break. One possible reason is that the substrate and tile expand to different extents upon exposure to heat. When a bathroom is aired for a

> “It is not just the tile which depends on the adhesive, but also the functionality, aesthetics and longevity of the room.”
>
> **Armin Hoffmann,** WACKER Technical Manager

FLEXIBLE SUPPORT TO PREVENT CRACKS AND SPALLING

Deformation behavior and shear force between tiles and substrate as regards flexible and rigid tile adhesives



Damage to tiles (cracks or spalling), caused by using rigid, non-deformable tile adhesives

Before large-format tiles are installed, the walls or floor need very careful preparation and must be level.

long time in winter, the tile surface might drop to a temperature of around 0 °C, compared with the 45 °C that shower water can reach. Such are the temperature differences that the system comprising tile–adhesive–wall has to withstand. Consequently, the sandwich layer – the tile adhesive – must not only create a strong bond but also be flexible as that compensates for any stresses. If the adhesive layer were rigid, the tile would crack or fall off. The fact that both thick and thin large-format tiles are susceptible to breaking is also due to the lower number of joints, which are also capable of accommodating stress. Small tiles have a much greater percentage area of joints than their larger counterparts and so cracks are prevented.

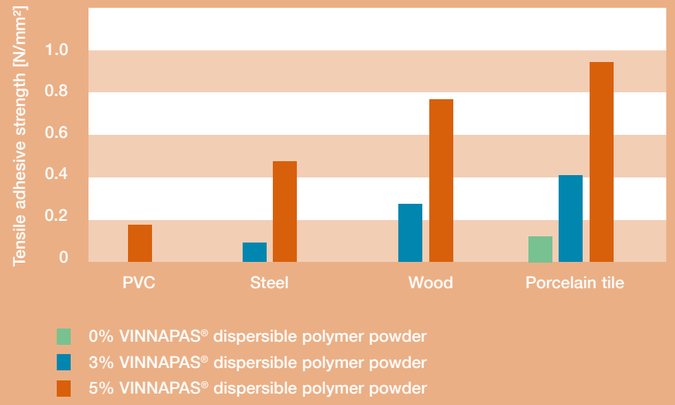
No matter whether they are thick or thin, large tiles weigh more and so are more difficult to attach to walls. Here, again, the tiles have to meet particularly high requirements: "You need very good non-slump properties when you are laying large-format tiles. For they allow you to set the tiles exactly where you want them in the adhesive bed," says Hoffmann. "We can now offer adhesive makers a new binder that features this property and also imparts the necessary degree of flexibility and bond strength. It rounds out our portfolio perfectly."

HIGHLY WATER-RESISTANT

VINNAPAS® 8812 T is a dispersible polymer powder based on a terpolymer of vinyl acetate, vinyl chloride and ethylene that provides adhesives with high water resistance, high non-slump properties and very good workability. As a result, the tiles stick to the wall when the adhesive is still damp, and they can be readily adjusted. Many tile adhesives and troweling compounds require additives in order to achieve strong adhesion or high non-slump properties. These additives are not needed with VINNAPAS® 8812 T.

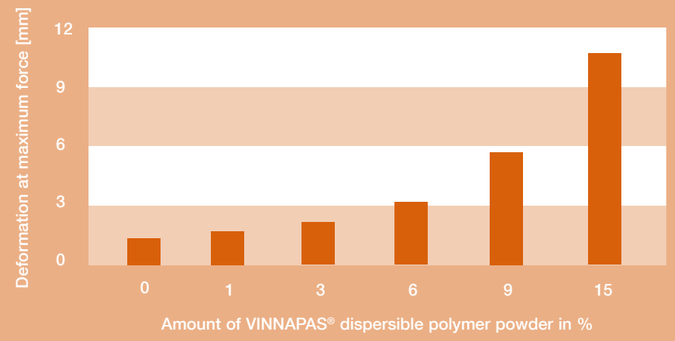
ADHESION ON CHALLENGING SUBSTRATES

Schematic depiction of the tensile adhesive strength of tile adhesives – modified to varying degrees – on challenging substrates. Tensile adhesive strength rises with increasing polymer content. (Test as per EN 12004-2)



EFFECT OF VINNAPAS® DISPERSIBLE POLYMER POWDER ON DEFORMABILITY (FLEXIBILITY)

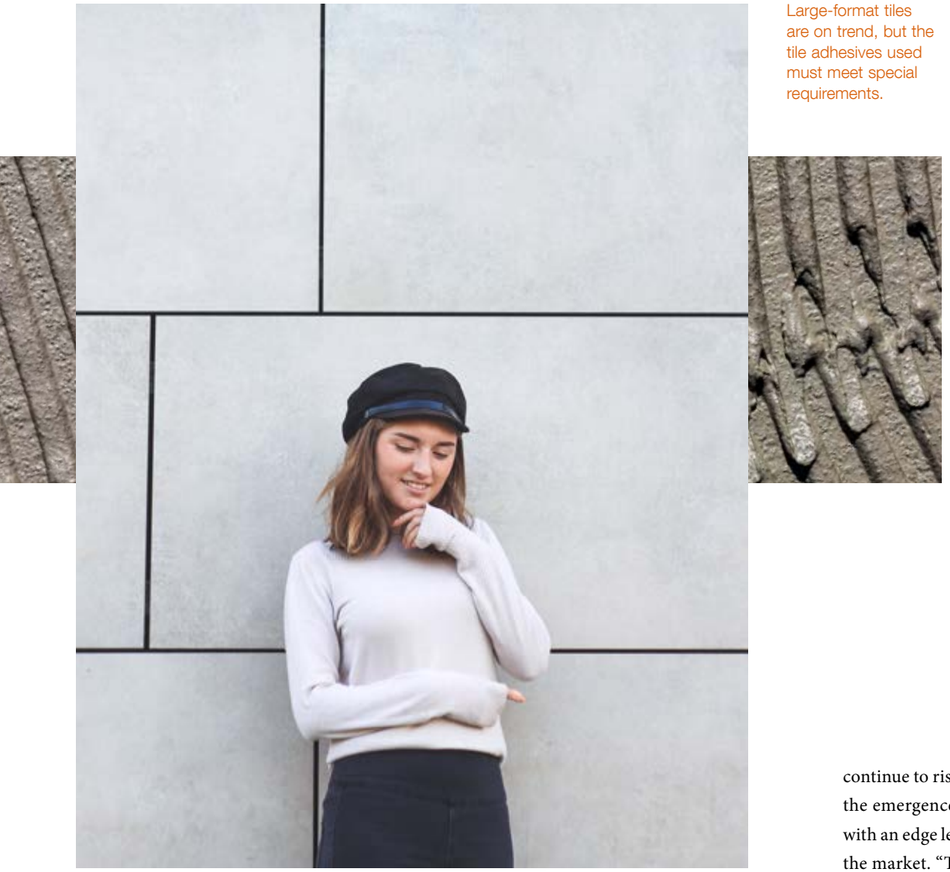
Deformability of mineral tile adhesive (35% Portland cement). Test performed in line with EN 12004-2 deformation test (see image on right). Storage conditions: 7 days' standard climatic conditions + 14 days' immersion in water + 21 days' standard climatic conditions (standard climatic conditions = 23 °C/50% relative humidity)



As manufacture involves neither plasticizer nor solvent nor film-forming additive, the dispersible polymer powder is also suitable for formulating low-emission tile adhesives for the thin-bed technique. This requires less tile adhesive – and fewer raw materials – and the tilers can work more economically while conserving resources. Wall and floor tiles can be laid up to four times faster by the thin-bed technique than by the thick-bed approach. At an application rate of around 3% dispersible polymer powder, it is also possible to cut down on as much as 90% of the raw materials sand and cement.

A further challenge facing tilers is the adhesive's open time. This is the length of time during which the adhesive can be worked before it starts setting. Stated in minutes, the open time indicates how much time can elapse between setting

The deformability of tile adhesives is tested to EN 12004-2 at WACKER's applications laboratory.



Large-format tiles are on trend, but the tile adhesives used must meet special requirements.

a tile in the adhesive bed and attaining a tensile adhesive strength of ≥ 0.5 MPa. The EN 12004 standard on tile adhesives specifies a minimum open time of 30 minutes. Anything longer than that is welcomed by tilers for they can then cover a larger area with adhesive and set the various tiles in place without the compound already starting to harden. "VINNAPAS® 8812 T in combination with other additives, such as methyl cellulose, extends the open time substantially and so makes the job of tiling much easier," says Hoffmann. This is just as important for large tiles as for small ones. Comparative tests in WACKER's applications laboratory show that the open time can be extended by up to 50%, the exact figure depending on the recipe involved.

No matter which trends emerge within the tile sector in the future, adhesive manufacturers' recipes will continue to focus on the binders on account of their many talents. Even now, it is apparent that the demands on tile adhesives will continue to rise: for example, we are now seeing the emergence of extra-large formats, i.e. tiles with an edge length of 1.20 meters and more, on the market. "The sector is also addressing sustainability," says Halbach. "As a raw-materials producer, we are among those working on optimizing our production processes in this regard and on avoiding emissions and boosting production efficiency, for example." In order that dry-mix mortar manufacturers can continue to provide tilers with optimum recipes for the full range of tiles available, WACKER offers the services of its specialists, who have the necessary expertise and a wide range of dispersible polymer powders that are being improved all the time. After all, it is not just the tile which depends on the adhesive, but also the functionality, aesthetics and longevity of the bathroom – and thus consumer satisfaction.

VINNAPAS® CATEGORIES

To simplify your choice, we have summarized our VINNAPAS® grades into six product classes

L

VINNAPAS® L Class – Optimized leveling characteristics
Ensures smooth surfaces with outstanding leveling properties, such as for self-leveling flooring compounds

T

VINNAPAS® T Class – Highly thixotropic
Ensures excellent thixotropic properties, as required in thixotropic tile adhesives and smoothing and/or leveling compounds

E

VINNAPAS® E Class – Improved properties
Enhances the properties in many applications, resulting in greater ease of processing, adhesion and water resistance

H

VINNAPAS® H Class – Hydrophobic excellence
Ensures notable hydrophobic properties in all kinds of plasters, grout mortars and external thermal insulation composite systems (ETICS/EIFS)

N

VINNAPAS® N Class – Neutral effect on rheology
Ensures a high level of formulation flexibility and a diverse range of applications

F

VINNAPAS® F Class – Superior flow properties
Ensures outstanding flow properties without the addition of synthetic superplasticizers or casein; suitable for self-leveling flooring compounds that require immediate liquefaction and a specific rheology

A HEALTHY HOME

Anyone who is doing some painting and decorating and is reluctant to bring harmful substances into their house will choose paints that bear ecolabels. New VINNAPAS® EP 3560 binder from WACKER is aimed at interior wall paints and offers a compelling blend of high-end properties and an extremely low level of harmful substances.

In particular, high concentrations of VOCs in indoor air tend to occur straight after construction or renovation work.

"One advantage of our VAE binders is that they can be used to formulate particularly low-emission paints."

Dr. Lada Bemert, Senior Technical Service Manager, WACKER POLYMERS

Sunshine-yellow dispels bad moods, pine green has a calming effect and purple shades convey solemnity. However, although paints give character to a room and create the desired atmosphere, it takes more than the visual appearance to transform a living room, bedroom or child's nursery into a relaxing living space. The air that we breathe there needs to be safe and to contain as few harmful substances as possible. And it is here that volatile organic compounds (VOCs) have come in for most criticism. Problem is, there is no consensus on what exactly constitutes a VOC. It is an umbrella term for all kinds of individual organic substances that readily evaporate, including alcohols, aldehydes, ketones and esters. These may be part of the formulation for the interior paint or be left over from the production process. As the paint dries, they escape into the air. In particular, high concentrations of VOCs in indoor air tend to occur straight after construction or renovation work. But over the long term, too, wall paints can emit a number of these substances. That can lead to irritation of respiratory organs and eyes or to headaches in sensitive people.

It is no surprise, then, that consumers are increasingly calling for products that emit as few VOCs as possible – and even legislators are trying to minimize VOC content. The EU Decopaint directive specifying the solvent content in various products has been in force since 2004. In 2010, the limit values for each substance were again tightened up sharply by 10% to 30% on average.

PAINTS BEARING AN ECOLABEL

For paints and coatings manufacturers, this EU directive poses a real challenge and an incentive to seek out alternatives to their usual raw-materials base. WACKER has come up with one such alternative in its vinyl acetate-ethylene or VAE binders which it markets under the name VINNAPAS®. They are suitable for formulating

paints, plasters and primers. “Our VAE binders have the advantage of supporting the formulation of particularly low-emission paints,” says Dr. Lada Bemert, a senior technical service manager at WACKER POLYMERS. To be sure, the members of the VINNAPAS® family already offer very low VOC emission values, but the chemists at WACKER have succeeded in lowering them even further.

LOW VOC EMISSIONS

“In VINNAPAS® EP 3560, a refinement of the tried-and-true VINNAPAS® EP 3360, we have developed a binder with which wall paints can meet the requirements of various eco-labels, such as the Nordic Swan ecolabel for indoor paints and varnishes,” says Dr. Martin Schierhorn, a marketing manager at WACKER POLYMERS. “Paint makers now have a solution that can help them meet the growing demand for lower-emission paints.”

A huge advantage is that WACKER’s VAE technology already makes do without organic solvents and so is ideal for formulating paints that have low-VOC emissions. And the reason is the chemical structure: VAE copolymers are are partly hydrophilic (water-loving). So, instead of organic solvents, water can serve as the coalescing agent or film-forming aid. As a coat of paint dries, it contracts in volume, drawing the pigments, fillers and polymer coils closer to one another. The particles have less room to maneuver, the polymer chains straighten out and the tangled structure reorganizes itself into a coherent polymer film. This process is subject to a threshold temperature. Thus, the film-forming temperature of WACKER’s VAE binders for use in paints is close to freezing point. Paints formulated with different polymers would not form a film at these temperatures. They need the additional help of organic solvents, which evaporate as the paint dries and are responsible for the bulk of the VOCs.

Despite their advantages, paints formulated with VAE binders are not entirely free from VOC emissions. The reason is to be found in the production process, which creates byproducts that can lead to a slight release of volatile organic compounds from the paints.

“Aside from the monomers, the free-radical polymerization process requires further substances, e.g. for starting and stopping the chemical reaction or for stabilizing the resulting colloids,” says Bemert. “We worked intensively on the polymerization and composition of the binder, swapping various substances to lower the VOC emissions even further. At the same time, we never lost sight of the property profile, which naturally had to be just as outstanding as before.”

ENHANCED DISPERSIBILITY

The extensive research work has culminated in VINNAPAS® EP 3560, a high-quality,

Paint containing VINNAPAS® EP 3560 is applied to a cinder block test piece at WACKER’s applications laboratory.

Wall-paint comparison: in an alkaline hydrolysis resistance test, the test piece on the left, coated with paint that contains VINNAPAS® EP 3560, exhibited no efflorescence. The test piece on the right, which was treated with conventional paint, showed significant efflorescence in the lower section.

> “Our new binder supports the formulation of low-odor paints that have lower VOC emissions.”
>
> **Dr. Martin Schierhorn**, Marketing Manager at WACKER POLYMERS

lower-emission product. As Schierhorn says, “Our new binder not only supports the formulation of low-odor paints that have lower VOC emissions. We have also optimized its dispersibility.” In other words, the binder disperses the fillers and pigment particles much more finely. The finer the dispersion, the better the color development and color consistency. A further bonus is that the new binder confers greater alkaline hydrolysis resistance on wall paints. “As a result, paints based on VAE are better equipped to counteract efflorescence and so are ideal for primers applied to alkaline substrates, such as concrete,” explains Bemert. “This means that the new binder prevents salts from within the masonry from penetrating through the coat of paint to the surface, where they lead to unsightly color changes. What’s more, the paints are breathable. This is a key criterion for preventing mold formation.”

Like VINNAPAS® EP 3360, the new product features high wet-scrub resistance and makes for excellent processing even at low temperatures. “As before, the minimum film-forming temperature of VINNAPAS® EP 3560 is around two degrees Celsius,” says Schierhorn. In other words, paints and plasters based on VINNAPAS® EP 3560 do not need organic solvents to form good films even at low temperatures, which means they will also emit fewer VOCs. “Our new product is a first-rate binder for matt to semi-gloss paints,” he explains, summarizing the benefits.

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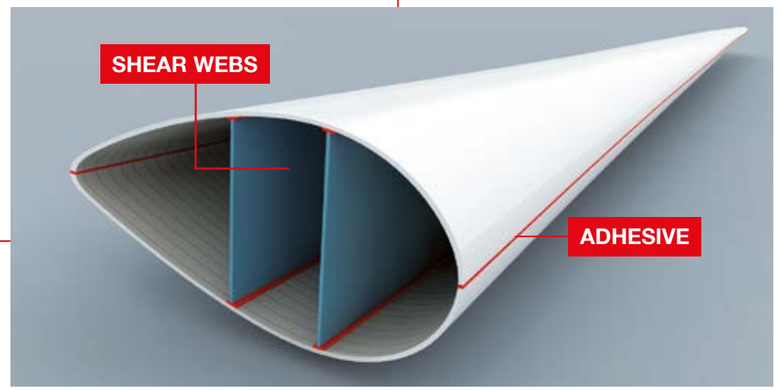
The latest generation of wind turbine blades measures up to 80 meters in length. During operation, powerful forces act on the rotors, the half-shells of which are bonded rather than fitted with screw connections.

HDK® PROVIDES SAG RESISTANCE

In order to apply industrial adhesives in automated processes, manufacturers have to be able to adjust adhesive flow properties precisely. A new pyrogenic silica from WACKER improves not only the viscosity of the adhesives, but also the manufacturing process. Despite its pronounced hydrophobicity, HDK® H21 can be incorporated into liquid adhesives quickly and easily.

PRECISE ADJUSTMENT

When rotor blades are manufactured for wind turbines, an epoxy adhesive is used for bonding the rotor blade half-shells (white) to shear webs (reinforcement elements; blue). This involves applying a thick layer of adhesive to the bonding surfaces (red line). WACKER pyrogenic silicas ensure the sag resistance of the adhesive by allowing producers to precisely adjust the thixotropy of the formulation.



Adhesives are what make wind power possible: the rotor blades – as much as 80 meters long in newer on-shore wind turbines – consist of two half-shells bonded firmly together with reinforcement elements, known as shear webs. These adhesive bonds are capable of transmitting the powerful forces that arise during turbine operation. Other industrial sectors are turning to modern high-performance adhesives for their joining technologies as well: the automotive industry bonds a variety of materials together and needs crash-proof bonds. The construction industry is replacing traditional dowels with chemical ones,

For most structural bonds, industry uses adhesives based on epoxy resins, vinyl ester resins or polyurethanes. When using polar, high-performance adhesives such as those in automated processes, manufacturers introduce rheological additives to modify the flow properties of adhesives as needed, thus ensuring flawless, reproducible application on the bonding surfaces.

HDK® H18, a highly hydrophobic – water-repellent, in other words – pyrogenic silica from WACKER sets the benchmark for rheological effectiveness. The additive's pronounced hydrophobicity plays a critical role in making it effective. Powerful mixers are required, however, for incorporating and dispersing HDK® H18 silica into polar adhesive formulations within an efficient amount of time.

PYROGENIC SILICA

Silicon dioxide in highly pure, amorphous form with a large surface area results when chlorosilanes are combusted in an oxyhydrogen flame at temperatures between 1,200 and 1,500 °C. The chemical reaction can be described as chlorosilane hydrolysis. In the hottest portion of the flame, the first compound to form is molecular silicon dioxide. As they move through colder regions, the molecules agglomerate to form spherical liquid particles, or protoparticles. The diameter of these droplets continues to grow as long as they remain liquid. At the end of this phase, they reach some 10 to 50 nanometers in diameter, at which point they are only partly liquid and are then referred to as primary particles. When primary particles collide, they do not entirely merge to form larger spherical particles – they instead fuse to become highly branched aggregates ranging in size between 100 and 500 nm. At the colder end of the flame, these aggregates solidify completely and assemble into structures held together by hydrogen bridges and reaching sizes of over 1 micrometer. Within these structures, which are known as agglomerates, the aggregate particles develop into a three-dimensional network that is more or less sensitive to shear forces – in other words, it can be broken back down into aggregate particles or smaller agglomerate units. The stability of these networks plays an important role when silicas are used for adjusting the flow properties of liquid products.

This is where HDK® H21 comes into play, a product that WACKER unveiled to a broad technical audience at this year's European Coatings Show. "Besides being significantly easier to incorporate into polar liquids, our new product also stands out for its exceptional rheological effectiveness," explains Anna-Maria Biebl, director of the HDK® EMEA/India business team at WACKER.

The prominent feature of all pyrogenic silicas is their large specific surface area of up to 400 m^2/g, which is due to their particle structure: "The smaller the primary particles that make up the aggregate, the larger the resulting particle surface and the denser the network," explains Dr. Ingmar Piglosiewicz, technical service manager for hydrophobic HDK® at WACKER.

CLOSE-MESHED NETWORK

A close-meshed network naturally does a better job of withstanding shear forces than a loose, open-pored one, which is why silicas can be used for adjusting the flow properties of liquid products.

The size of the specific surface area is also reflected in a large number of additional product characteristics. HDK® H18 and HDK® H21 are based on particles with large specific surface areas – the area of even just a few grams of these grades is equivalent to that of a soccer field.

Silanol groups, which can be found on the surface of silica particles produced via flame hydrolysis (see column on left), lend the particles a polar and initially hydrophilic character. The reactivity of these silanol groups makes it possible to modify particles selectively using organosilicon compounds. In processes like this, the surface of the silica is made hydrophobic and non-polar, giving it water-repellent properties and consequently reducing the number of silanol groups available to reactive adhesive systems. Hydrophobizing the surface of the silica guards against reactions with adhesive resins, thus contributing to its shelf life.

CARBON CONFERS HYDROPHOBICITY

Hydrophobic HDK® is always produced in a process downstream from flame hydrolysis – by treating it with a polydimethylsiloxane (PDMS), for example, which is how WACKER produces HDK® H21 and HDK® H18. One way to gauge the degree of hydrophobization achieved is to determine the amount of carbon, which is incorporated into the silica by means of the methyl groups on the PDMS. The carbon content of HDK® H21 is roughly 5.5%. "That value is also high for a silica with a large specific surface area, which makes HDK® H21 an especially hydrophobic grade," Piglosiewicz explains. "That's an important prerequisite for controlling the flow properties of polar adhesives efficiently."

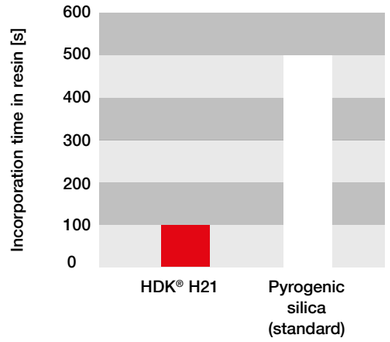
Highly hydrophobic and thus non-polar silicas are effective rheological additives for polar adhesive systems. The difference in polarity between hydrophobic, non-polar silica and the polar adhesive system causes the silica aggregates to interact more with each other, and less with the adhesive matrix. The interactions between particles produce stable agglomerate networks that ultimately yield the desired rheological effects.

On the other hand, highly hydrophobic silicas are very difficult to wet with polar adhesive systems, as the difference in polarity generally means that the time needed to incorporate the silica into the adhesive system is significant, requiring appropriate equipment. As a result, the use of hydropobic silicas, while necessary, poses challenges to manufacturers.

"Our developers have succeeded in significantly influencing the wetting behavior of silica hydrophobized with polydimethylsiloxane and considerably reducing the time it takes to incorporate the silica into polar adhesive systems," says Biebl, who is responsible at WACKER for

EASY TO PROCESS

The new HDK® H21 grade of silica can be quickly incorporated into polar adhesive resins. Comparison tests using epoxy resins and a silica concentration of 8% show that HDK® H21 can be incorporated into liquid epoxy resins much more quickly than other products, making this production step more efficient.



A member of WACKER's technical support team presses an epoxy resin adhesive onto a pane of glass. The adhesive sample at the bottom right has been formulated with HDK® H21 and therefore exhibits much better sag resistance – it does not run, unlike its counterpart.

marketing HDK® in EMEA/India. “That makes the silica easier to handle.” In the corresponding studies, the chemists at Burghausen took a particularly close look at epoxy, isocyanate, polyol and vinyl ester systems.

The formation of silica agglomerate networks in liquids is reversible – shear forces can convert agglomerates to aggregates or to smaller agglomerate units, which then revert to agglomerates when the forces subside. When liquid adhesive systems are in storage, the domains of silica networks increase viscosity, generate a rheological yield point and thus prevent adhesive components such as fillers from settling. Addition of silica, in other words, significantly improves storage stability. Even after the adhesive has been applied on a substrate, the silica networks are capable of resisting the effects of gravity and, by generating a rheological yield point, prevent the adhesive from running.

REVERSIBLE NETWORKS

“The use of silica makes it possible to produce formulations that do an exceptionally good job of resisting sag,” observes Piglosiewicz from WACKER Technical Support, summarizing the advantages of the additive. Users want the adhesive to be easy to process too, however, and that, in turn, requires lower viscosities. Shear forces act on the silica system during processing and application (mixing, pumping and extrusion). These forces break down the agglomerate networks, making the viscosity of the liquid formulations sufficiently low relative to their resting state.

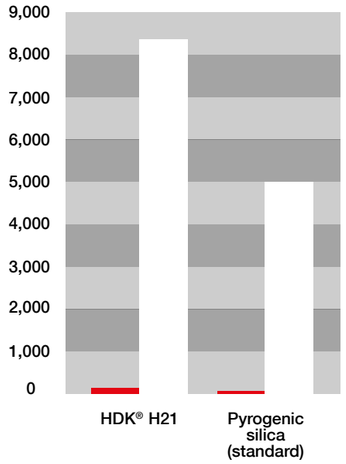
An epoxy resin rendered thixotropic with HDK® H21 is applied to an inclined pane of glass: the polar adhesive component containing HDK® does not run and the layer exhibits sag resistance.

As Piglosiewicz points out, “The formation of reversible silica networks in adhesive systems causes and enables both of these characteristics: high viscosity in liquid formulations at rest and low viscosity during processing and application.” This behavior is referred to as shear thinning or pseudoplasticity, also known as thixotropy.

The thixotropic effect makes for a reliable, flawless bond on inclined mating surfaces, such as those found in certain sections of the half-shells of wind turbines or in automobile bodies – the adhesive does not drip down from the mating surfaces. The effect is similar in chemical dowels, which are used for bonding heavy building elements, a process in which holes are drilled into the weight-bearing component of the building, and anchor bolts are glued into those holes. These bolts, in turn, serve as mounting elements for the component to be attached – a balcony, for instance. When the rheology of the structural adhesive used has been adjusted correctly, no adhesive will run out of the boreholes, so that the bolts always remain firmly anchored in the holes after curing.

VISCOSITY OF EPOXY RESIN FORMULATIONS

Addition of new HDK® H21 at a concentration of 8% (left two bars) makes a liquid epoxy resin highly viscous at a low shear rate (0.1 s^{-1}, white bar). The resin is thick when stirred slowly. If the shear rate is high, by contrast (10 s^{-1}, red bar), the viscosity drops precipitously, and the resin becomes thin. It follows that the addition of the new, highly hydrophobic silica greatly increases pseudoplastic behavior.



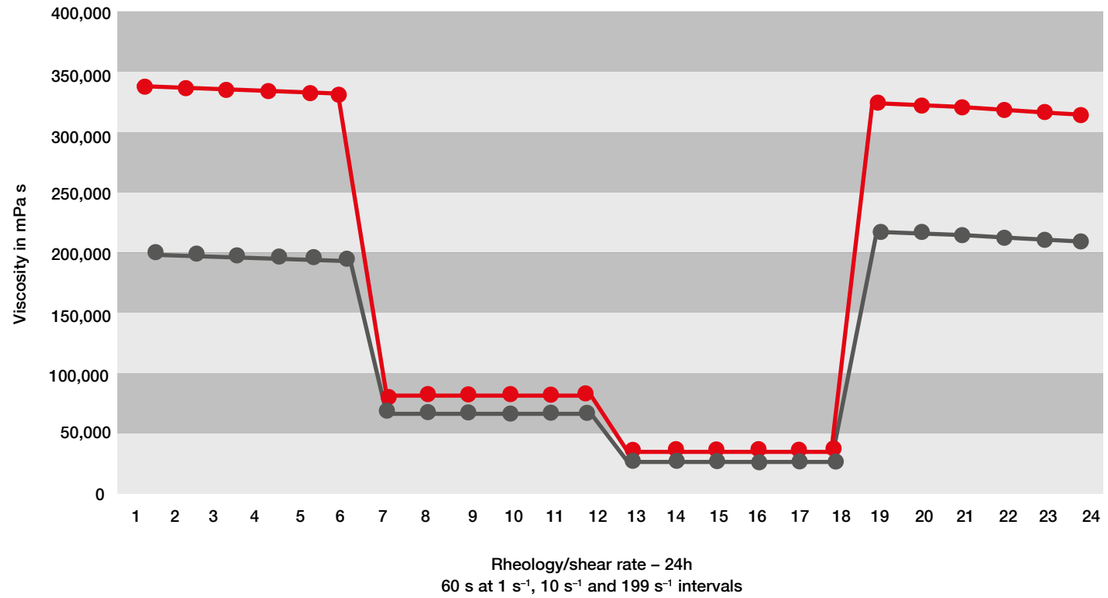
SIGNIFICANT DIFFERENCES

If the adhesive needs to be highly thixotropic, the polarity of the liquid phase and of the HDK® will differ significantly. The reason? When major differences in polarity are present, the aggregate particles of HDK® are drawn to form relatively shear-resistant agglomerate networks. The aggregates will then favor interactions with their own kind – and not with the physically different molecules of the liquid phase. This results in significant differences in viscosity between high shear rates, at which no HDK® agglomerate networks exist, and low shear rates, which allow the networks to form. Formulators can precisely calibrate the extent of the rheological effect by varying the amount of HDK® used.

Efficiently adjusting the flow properties of a polar industrial adhesive requires a non-polar and thus highly hydrophobic grade such as HDK® H21. “Because HDK® H21 is so rheologically effective, it also helps reduce the concentration of silica in highly polar formulations,” Piglosiewicz explains, noting that this could bring costs down as well. ■

VISCOSITY AND TIME

The degree to which hydrophobic pyrogenic silicas differ in terms of their rheological efficacy can be seen in these graphs of viscosity vs. time for a vinyl ester resin formulated with silicas. Viscosities were determined at each of the following shear rates: 1 s^{-1}, 10 s^{-1} and 199 s^{-1}. HDK® H21 (red curve) yields a significantly higher viscosity at low shear and produces a much more pronounced thixotropic effect than a standard hydrophobic silica (gray curve).



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REPELLING PESTS WITH NATURAL ESSENTIAL OILS

WACKER experts are working on physiologically harmless ways of keeping harmful insects out of houses. Functional coatings containing essential oils simply drive pests away by virtue of their odor. These formulations are stabilized by cyclodextrins which release the ingredients in a controlled manner.

Houses made of wood are particularly prone to ant or termite infestation.

Ants are not only a nuisance in your house, they can also cause considerable damage. Species that destroy wood infest load-bearing wooden parts and insulating materials. These insects particularly like to set up home inside false ceilings and are hard to get rid of.

Property owners are even more worried about termites, especially in the USA, where many houses are made of wood. According to the US Environmental Protection Agency (EPA), property owners spend $2 billion a year trying to undo the destructive work of termites.

SILENTLY IN THE BACKGROUND

What makes these tiny insects so dangerous is that they work silently in the background over a long period of time. The infested facade looks to be virtually intact from the outside, but it has been hollowed out from the inside. This makes the structure crumbly and promotes ingress of moisture. That in turn boosts rot and fungal growth, eventually compromising the stability of the entire building. Aside from wood, ants and termites will destroy paper, books, insulating materials and even swimming pool linings and filter systems.

"Such damage can remain hidden for years. Mostly, it takes professionals to clearly identify the signs of ant or termite infestation," says Mark Harrison, global business development manager at WACKER BIOSOLUTIONS in Adrian, USA

Getting rid of an infestation usually entails removing the damaged wood and giving the building a thorough once-over with pesticides. Setting poisonous bait is another way to eliminate insects. A third, and less radical option would naturally be to prevent the insects from establishing a foothold in the house in the first place. This might be achieved by rendering a wooden house unappealing to the pests – possibly with aromatic oils.

"Natural active ingredients could serve as a basis for formulating wall paints or other coatings that repel insects."

Mark Harrison, Global Business Development Manager, WACKER BIOSOLUTIONS

EFFECTIVE FRAGRANCES

Essential oils are obtained from comminuted plant parts. They chiefly consist of readily volatile terpenes, which are attractive for their biological and pharmacological properties, and also serve as fragrances and flavorings. Unlike fatty oils, such as olive and sunflower oil, which chiefly consist of non-volatile fatty acid esters, essential oils evaporate rapidly, generally without leaving behind any greasy stains on paper or fabrics. Many essential oils and their ingredients are surprisingly highly antimicrobial. Several scientific studies, for example, have shown that thyme oil is highly effective against bacteria and mold. Carnation and cinnamon leaf oil also are fungicidal. Cinnamon bark oil, by contrast, is highly antibacterial. What is more, as far as we know, the microorganisms are not showing signs of developing resistance to essential oils.

"Essential oils are coming to the fore in such application areas, because a number of these volatile natural products have a repellent effect on certain creatures," says Harrison. Thus, sprigs of lavender have been used since time immemorial to keep moths out of wardrobes. Many chemical compounds that can be isolated from essential oils possess this repellent property. For several years, research institutes, especially those located in tropical regions, have intensified their studies into whether and how essential oils can provide protection against various insects – not least for the sake of curbing the advance of diseases such as malaria and yellow fever, which are spread by insects. Spiders could be a possible target group for such applications as well, though they generally cause no damage to the house, some species in hotter regions can be poisonous for humans.

Industrial companies such as WACKER are working hard on rendering natural products useful for insect-repellency applications. As their constituents usually have a broad-spectrum effect, they hold out much promise in numerous, highly diverse applications. "The construction industry, too, has woken up to the potential of essential oils," explains Harrison. "Natural active ingredients could serve as a basis for formulating wall paints and other coatings that repel insects."

VOLATILE SUBSTANCES

Unfortunately, many essential oils have two major drawbacks. First, they exhibit very high chemical sensitivity – many of their ingredients are destroyed by air and light. Some of them undergo changes when heated together with, or in the presence of, acidic or alkaline media. They rapidly lose their efficacy as a result. "Some of the components wouldn't even survive being stirred into the plastering mortar or the wall paint," explains Harrison. Second, essential oils are so volatile that they

Top: Damage from ants to cracks in the walls of a house

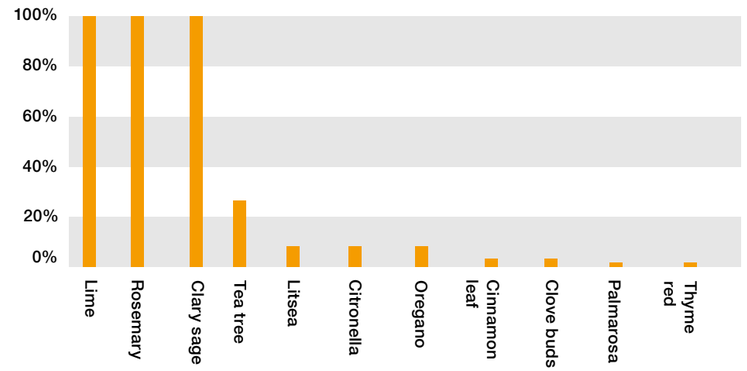
Bottom: Termite and rot damage to the foundation of a wooden house

Exterminator removing damage caused by termite infestation in a house

CONCENTRATION IN SPORE SUSPENSION IN ESSENTIAL OIL TO PREVENT SPORE GERMINATION BY FUNGHI

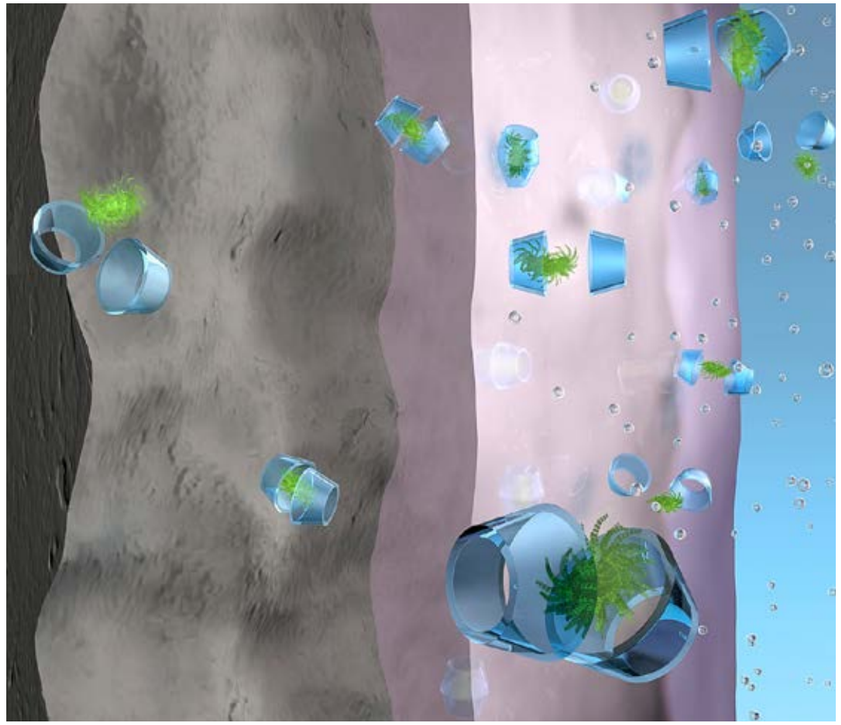
40 h incubation time

Botrytis cinera (gray mold)



TACKLING MOLD THE NATURAL WAY

In modern wall paints, especially interior paints, the vehicle is usually water, and not an organic solvent. This affords a way of slashing emissions that can harm the environment and damage health. The other side of the coin, however, is that water-borne paints are more susceptible to microbial attack. They offer ideal growth conditions for bacteria and fungi. So that the paint does not spoil before the consumer uses it, manufacturers add microbicides. Nowadays, these are mostly chemicals that kill off bacteria and fungi. The problem here is that these substances are often irritating to human skin and mucous membranes and have a detrimental effect on the environmental. There is therefore a general trend in favor of solutions that are based on natural, less harmful additives – for example, essential oils such as lavender, citronella and rosemary. Many of these natural products possess antimicrobial properties. However, they are readily volatile, insoluble in water and often chemically unstable. For these reasons, addition of the organic substance to water-borne paints is not straight forward. WACKER has solved this problem by using cyclodextrins. These ring-shaped sugar molecules accommodate the essential oils inside their lipophilic (fat-soluble) cavities, from where they can slowly evaporate and unfold their antimicrobial effect over a protracted period. At the same time, the cyclodextrins boost the solubility of the organic substances because their outer shells are hydrophilic (water-soluble). The experts at WACKER have already created formulations in which the essential oils are encapsulated within the ring-shaped sugar molecules. At the moment, variants with lavender, peppermint and citronella oil are available. These are suitable for water-borne paints.



Model showing the mode of action of cyclodextrin-fragrance complexes in wall paint. The ring-shaped sugar molecules (blue) can accommodate fragrances (green) within their cavities. These are released by moisture and emitted in a controlled manner to the environment.

will completely evaporate from the applied coating or film within a few days.

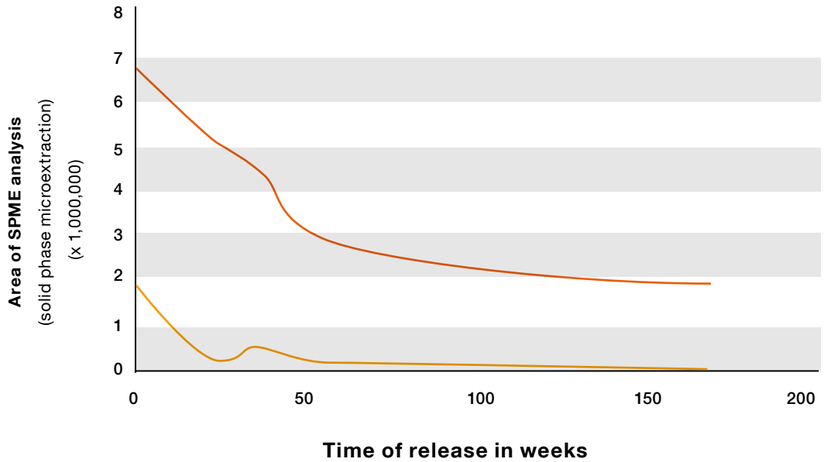
However, these drawbacks can be canceled out by a molecular trick: cyclodextrins from WACKER can be used to formulate functional coatings that protect the sensitive fragrances against destructive influences. Cyclodextrins are ring-shaped sugar molecules that can encapsulate and then release other molecules. WACKER bio-engineers cyclodextrins from cornstarch and sells them under the CAVAMAX® brand.

This molecular encapsulation artist has a hydrophobic cavity inside it that locks away the fragrances securely, as if they were in a tiny safe. The key to the safe is water molecules. “When moisture acts on this inclusion compound, the substances are released in their original form and are free to do their job,” says Harrison. “Our studies show that this form of release also works from dried coatings.”

PROOF OF REPELLENT ACTION

Together with an external partner, Harrison and his team are working on establishing cyclodextrins as a component of functional coatings and thus on rendering them useful to the construction industry. The idea is to incorporate the molecular safes, along with an insect-repelling essential oil, into wall paints that are not exposed to driving rain. Atmospheric moisture then determines how much of the fragrance is emitted to the ambient air. The more water molecules that are present in the atmosphere, the more fragrance is released. The cyclodextrins function like a reservoir, enabling the repellent to combat the pests continuously over a protracted period of time. Tests have confirmed that a commercial emulsion paint to which has been added a 5% complex of cyclodextrin and 0.5% citronella oil obtained from lemongrass, had a repellent effect on ants, for example. The protective and release mechanism works so well that the coatings functionalized with cyclodextrins can release the fragrance for up to three years. ■

CITRAL RELEASE FROM PAINT



Citral is a fragrance and aroma compound that forms the main constituent of lemongrass essential oil. What is more, it is released after more than three years if the wall paint is formulated with citrus oil and cyclodextrins.

Citral with water
Citral without water

Ants like to build their nests in the roof truss of houses and can cause considerable damage to the beams and insulation.

CONTACT

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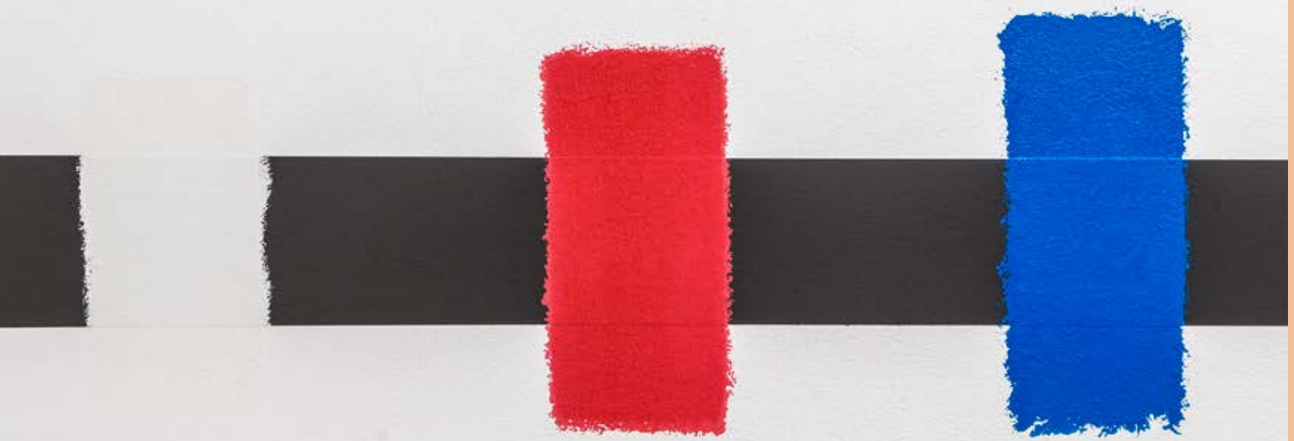


The hiding power of powder paint formulated with NEXIVA® is tested with these stripes of paint.

DISPERSIBLE POLYMER POWDERS FOR BIOCIDE-FREE WALL PAINTS

With WACKER's new NEXIVA® product range, interior wall paints can be manufactured in powder form without added biocides.

Most wall paints are produced using water-based binders or raw materials. When used in paints, however, water provides a favorable environment for microbes and bacteria. In order to kill these organisms, the paints are typically formulated with biocides to make them last longer. According to the German Paint and Printing Inks Industry Association, one in four buckets of paint will spoil unless preservatives are added. That translates to eleven million buckets per year, at a cost of €470 million. Using biocides is problematic, however: they can cause an allergic reaction in some people.

With NEXIVA®, WACKER has now developed a technology for producing biocide-free paints. At the 2019 European Coatings Show, the Group will be presenting a product line based on spray-dried polymeric binders suitable for producing interior wall paints in either liquid or powder form. Just like traditional binders in dispersion form, paint manufacturers can use NEXIVA® to create individual paint formulations.

Powder paints remain stable, even without the addition of preservatives. Water for redispersing the paints is not added until just prior to application, thus eliminating the need for adding biocides during production. Thanks to the polymers, the paint adheres well and has good spreading properties. In addition, paints are easier to transport and store when they are in powder form, as they weigh less, for instance, and can be packaged differently from liquid paints. Unlike traditional wall paints, powdered versions do not freeze in the cold, nor do they thicken when exposed to heat.

Formulation of NEXIVA® based powder paint and red pigments.

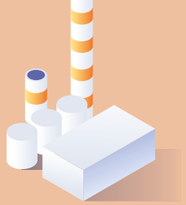
WACKER IN FIGURES

Biotechnology is a driving innovator for the key sectors WACKER supplies with products and applications. Using advanced biotech processes, WACKER BIOSOLUTIONS provides tailored, innovative solutions and products, including pharmaceutical proteins, cyclodextrins and fermentation-generated cystine and cysteine. Its portfolio is complemented by catalog chemicals, such as acetylacetone and high-quality polyvinyl acetate solid resins.

are currently working for WACKER BIOSOLUTIONS. The workforce has almost doubled since the division was restructured in 2010.

+10%

is the figure by which WACKER BIOSOLUTIONS grew in 2018 against the year earlier. The business division's sales totaled some €227 million.



7 Sites

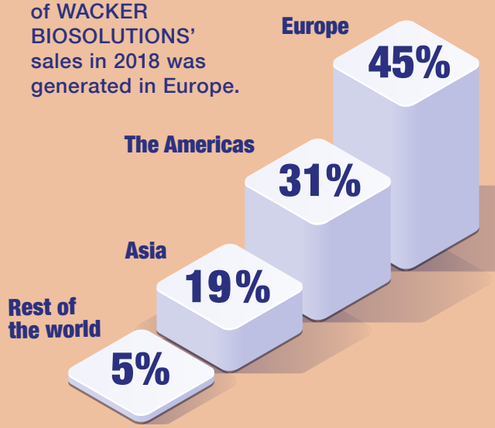
belong to the WACKER BIOSOLUTIONS production network: Eddyville (Iowa) in the USA; Amsterdam in the Netherlands; Burghausen, Jena and Halle in Germany; León in Spain; and Nanjing in China.

3 Core Markets

are at the heart of WACKER BIOSOLUTIONS: pharmaceuticals, food and agriculture

45%

of WACKER BIOSOLUTIONS' sales in 2018 was generated in Europe.



4 Technical Competence Centers

develop products and applications tailored to WACKER customers on three continents (North America, Europe and Asia).

SAY GOODBYE TO SORE MUSCLES

Aching muscles are the bane of an athlete's life. A host of theories proclaim to have the best cure for this ailment. An all-time favorite is heat. By increasing blood circulation, it accelerates the healing process. While remedies depended on hot baths or saunas in former times, a modern answer comes in the form of curcumin, an extract from the turmeric plant. For thousands of years, turmeric has been used as one of the most effective antioxidants in Ayurvedic medicine. Studies show that curcumin can support you during workouts and help regenerate muscles.

WACKER

CAVACURMIN® is a formulation based on gammadextrin and curcumin. These ingredients drastically increase the bioavailability of this antioxidant with its anti-inflammatory and antibacterial properties. The powder-form formulation can be easily processed in food supplements, such as tablets, capsules, energy bars and functional beverages.