Wacker Chemie AG
Hanns-Seidel-Platz 4
81737 München, Germany
www.wacker.com

FEATURES

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Versatile Fragrances: Walls with New Functions

Essential oils are much sought-after. They can change your mood, combat microbes and repel pests. But their action is only fleeting – they are volatile and quickly degrade. So far, this has prevented their use in the construction industry. But WACKER has developed a method of stabilizing volatile fragrances. As a result, dispersion paints and traditional binders can perform novel functions.

Essential oils smell good …

Mention “essential oils” and we think of strong-smelling plants, of jasmine, rose, lavender blossom, lemon peel and cinnamon, but also of fragrant herbs – we value their pleasant scent and the aroma they impart to food and drink. Technologists go a step further. They are trying to exploit essential oils’ full range of benefits, since these volatile materials do far more than just smell good.

... and are purely natural products

Essential oils are derived from crushed plant material – leaves, flowers, fruit, peels, seeds, roots, bark or wood. The precious oils are extracted from these materials by physical processes. A commonly used method is steam distillation, in which steam entrains the volatile oils. The “agrumen” essential oils contained in the peel of citrus fruit are extracted by cold pressing.

Grease spots? Not with essential oils

Unlike fatty oils such as olive or sunflower oil, essential oils quickly evaporate, usually without leaving grease spots on paper or textiles. Their volatility is the reason for their other name of

"ethereal" oils, originally meaning "celestial" or "transient."

Some creatures give them a wide berth

Only one percent of all known plant species produce essential oils. We are only just beginning to understand why these particular plants produce essential oils and what functions the oils perform. Many of these plant fragrances attract pollinating insects and so help to propagate the species. Others protect against pests. Some essential oils act as deterrents to particular creatures. For example, moths steer clear of lavender blossom.

Fragrances repel birds and mosquitoes

Many individual substances isolated from ethereal oils have a deterrent effect. For example, the methyl anthranilate found in orange blossom oil repels birds. Mosquitoes and horseflies avoid the smell of eugenol and geraniol. Eugenol is the main component of oil of cloves and cinnamon leaf oil. Geraniol is present in high concentrations in palmarosa and citronella oil, and is one of the most widely used fragrances of all. That is the reason why these two fragrances are used in mosquito repellents. For several years, research institutes, particularly those in tropical regions, have been looking for ways of using ethereal oils to protect against insects such as mosquitoes or termites – not least as a way of controlling malaria and yellow fever.

Antimicrobial effect

Some ethereal oils can inhibit the reproduction of bacteria and molds. Cooks know that they can keep raw meat fresh for longer by spicing it with cloves – the dried buds of the clove tree – or fresh thyme. Many ancient household remedies and increasing numbers of pharmaceutical preparations make use of the antimicrobial effect of ethereal oils. In pharmacies, many gargles for treating oral and throat infections contain thyme oil,

often combined with tea-tree, peppermint and/or eucalyptus oil. We know now that some ethereal oils and their components have an astonishingly effective antimicrobial action. Though natural products, they ultimately derive their effect from chemicals they contain, such as phenols and aldehydes.

Highly effective: thyme, clove and cinnamon bark oil

Several scientific studies have shown that the oil derived from red thyme is highly effective against both bacteria and molds. The oil mainly derives its action from thymol, its main constituent. Thymol is around 30 times as effective as the disinfectant phenol that was formerly commonly used in hospitals (also known as carbolic acid or hydroxybenzene). The strong antifungal effect of clove oil or cinnamon leaf oil has been clearly demonstrated in a number of studies, while cinnamon bark oil is notable for its strong antibacterial effect. But, even with the strongest-acting oils, the effect never lasts long – they evaporate too quickly. Though, as compensation, the oils and their components have another advantage: so far as is known, microorganisms do not develop resistance to essential oils.

Fragrances can affect your mood

The fascination that ethereal oils hold for many people is the result of the psychological effect of natural fragrances. Ethereal oils – like all fragrances – can affect people's moods and trigger emotions. The reason for this is the close link between the olfactory sense and the limbic system. This part of the brain – very old in evolutionary terms – controls emotions, affects and urges. The brain remembers which odors have occurred in which situations. Encountering a particular odor again rekindles the memory of the former situation.

The construction industry wants multi-functional construction materials

"With such a wide range of effects, essential oils have attracted widespread interest for a host of highly diverse applications," says the chemist and perfumer Marlies Regiert. Ms. Regiert is responsible for development, marketing and sales of cyclodextrin products at WACKER FINE CHEMICALS. "It is not surprising, then, that construction specialists have also become aware of essential oils. Ethereal oils could give plasters, paints and other coatings hitherto inconceivable properties, which would be invoked simply by exposure to moisture."

Stabilization is essential

However, there are two obstacles to using such oils in the construction industry. First, many essential oils are very chemically sensitive. Several of their ingredients are oxidized by exposure to air and light; others are chemically changed by heat or the effects of acids or alkalis. This renders oils ineffective; in extreme cases they are even transformed into harmful substances. Some components would not even withstand the shearing action of mixing them into the plaster-mortar paste or liquid wall paint. Essential oils' other Achilles' heel is their volatility – they would evaporate from the applied coating or surfacing within just a few days.

The solution is to lock them up in molecular strongboxes…

... but with a key to open them.

Ms. Regiert has found a way to overcome all these obstacles. She protects the sensitive fragrances by molecular inclusion in β-cyclodextrin. The ring-shaped molecules of this sugar can receive a fragrance molecule in their cavities. "Each cyclodextrin molecule acts like a small strongbox, securely protecting a fragrance molecule against the chemical effect of its surroundings," says Ms. Regiert. "The key to opening the tiny strongbox is water." When water acts on the inclusion compound, the fragrance

is liberated in its original form.

Controlled release over many years

Thus, a cyclodextrin inclusion compound offers a convenient vehicle for employing fragrances in construction applications – like flooring or plasters – that are not exposed to direct rain. Here, atmospheric moisture determines how much fragrance is released to the ambient air. The more humid the air, the more is liberated. The sensitive fragrance does not evaporate away, and it cannot be chemically changed. The protection and release mechanism is so effective that a coating still liberates almost as much fragrance after several years' use as it did at the start.

Practical tests exploit the potential

Several construction material manufacturers are currently testing binders containing fragrance-complexes under various climatic conditions to exploit their applications potential and gather early practical experience. A main focus is on applications in public areas, such as subway and light rail systems, airports, underground garages and public restrooms. The particular fragrance released will depend on the application.

Wellbeing is enhanced even at inhospitable place

The benefits of essential oils on people's psyches and emotional wellbeing could soon be exploited in inhospitable buildings. Ms. Regiert has her sights set on subway and light-rail stations, where people are crowded together, as well as multistory and underground parking lots, and public restrooms. "Paints or coatings that continually emit a particular fragrance could help to generate a less aggressive, more relaxed atmosphere. The air in some Paris metro stations is already perfumed." Likewise, in public restrooms, a suitable fragrance contained in the wall paint might create a more comfortable atmosphere, emitting freshness

New functions for building materials – based on renewable raw materials

and cleanliness.

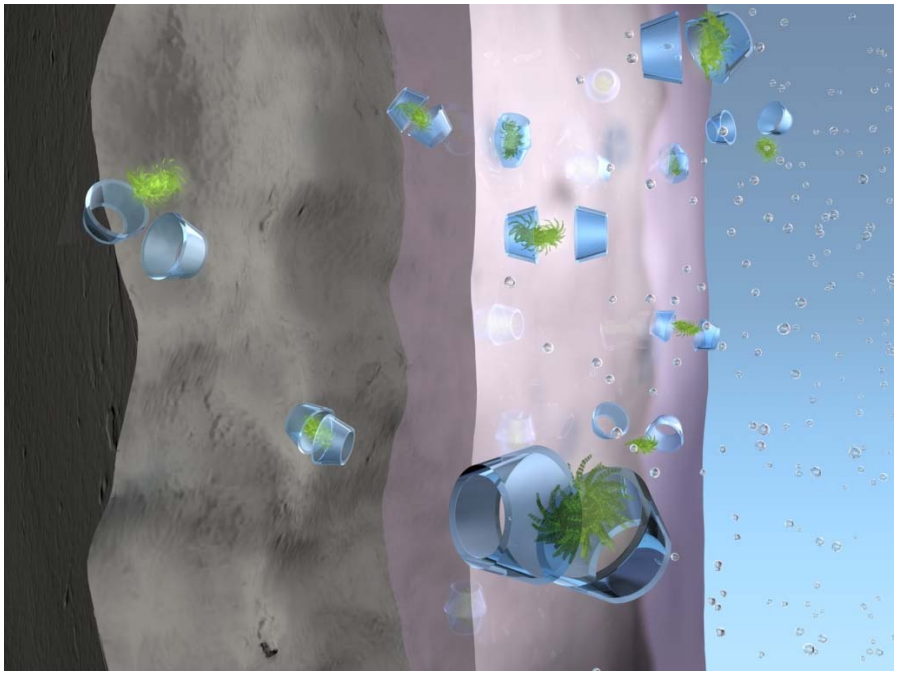
With cyclodextrin-fragrance-complexes, traditional construction binders gain new functions – all of them based on renewable plant extracts. .

The Background to Cyclodextrins

Cyclodextrins are non-reducing chiral sugars, whose molecules are made of several glucose building blocks linked into a ring. According to the number of glucose units – and therefore the ring size – a distinction is made between α, β and γ-cyclodextrin. α-Cyclodextrin has six , β-cyclodextrin seven, and γ-cyclodextrin eight glucose units. Cyclodextrins are natural degradation products of starch. WACKER FINE CHEMICALS produces cyclodextrin from phytomaterials by a bio-engineering method.

In the cyclodextrin molecules, the glucose building blocks are arranged so that they have a lipophilic cavity (i.e. one with an affinity for fat) in their interior. This cavity can receive another lipophilic molecule as “guest,” provided that it has the correct size and shape. The cohesion between the two molecules is relatively weak (van der Waals forces), so that the guest molecule can be liberated again under suitable conditions. The weak van der Waals forces in such inclusion compounds leave the two counterpart molecules unchanged.

This ability to enclose other substances reversibly makes cyclodextrins invaluable in many products and industries, such as household and personal care, pharmaceutical and cosmetic preparations, textiles and foods.



Model of cyclodextrin fragrance complexes in wall paints: The ring-shaped sugar molecules can host fragrances in their inner cavity. Set off by moisture, they are released to their surrounding in a controlled manner (photo: Wacker Chemie AG).

At the Adrian technical center in the USA, a chemist prepares a cyclodextrin inclusion compound. The ring-shaped sugar molecules are used, for example, to improve the solubility or stability of substances, reduce their volatility or mask unpleasant odors (photo: Wacker Chemie AG).

Taking a sample from a wall treated with a coating containing cyclodextrin fragrance complexes. By molecular inclusion in cyclodextrin, for the first time, essential oils and other fragrances can be used in plasters, paints and other coatings (photo: Wacker Chemie AG).

Note:
These photos are available for download at
http://www.wacker.com/presseinformationen

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For further information, please contact:
Wacker Chemie AG
Media Relations & Information
Nadine Baumgartl
Tel. +49 89 6279-1604
Fax +49 89 6279-2604
nadine.baumgartl@wacker.com

The company in brief:
WACKER is a globally active chemical company with some 15,900 employees and annual sales of around €4.3 billion (2008).
WACKER has 27 production sites and over 100 sales offices worldwide.

WACKER SILICONES
Silicone fluids, emulsions, rubber and resins; silanes; pyrogenic silicas; thermoplastic silicone elastomers

WACKER POLYMERS
Polyvinyl acetate and vinyl acetate copolymers in the form of dispersible polymer powders, dispersions and solid resins used as binders for construction chemicals, coatings, adhesives, paints, plasters and nonwovens

WACKER FINE CHEMICALS
Fine chemicals, biologics and other biotech products such as cyclodextrins and cysteine

WACKER POLYSILICON
Polysilicon for the semiconductor and photovoltaics industries; solar wafers

Siltronic
Hyperpure silicon wafers and monocrystals for semiconductor devices