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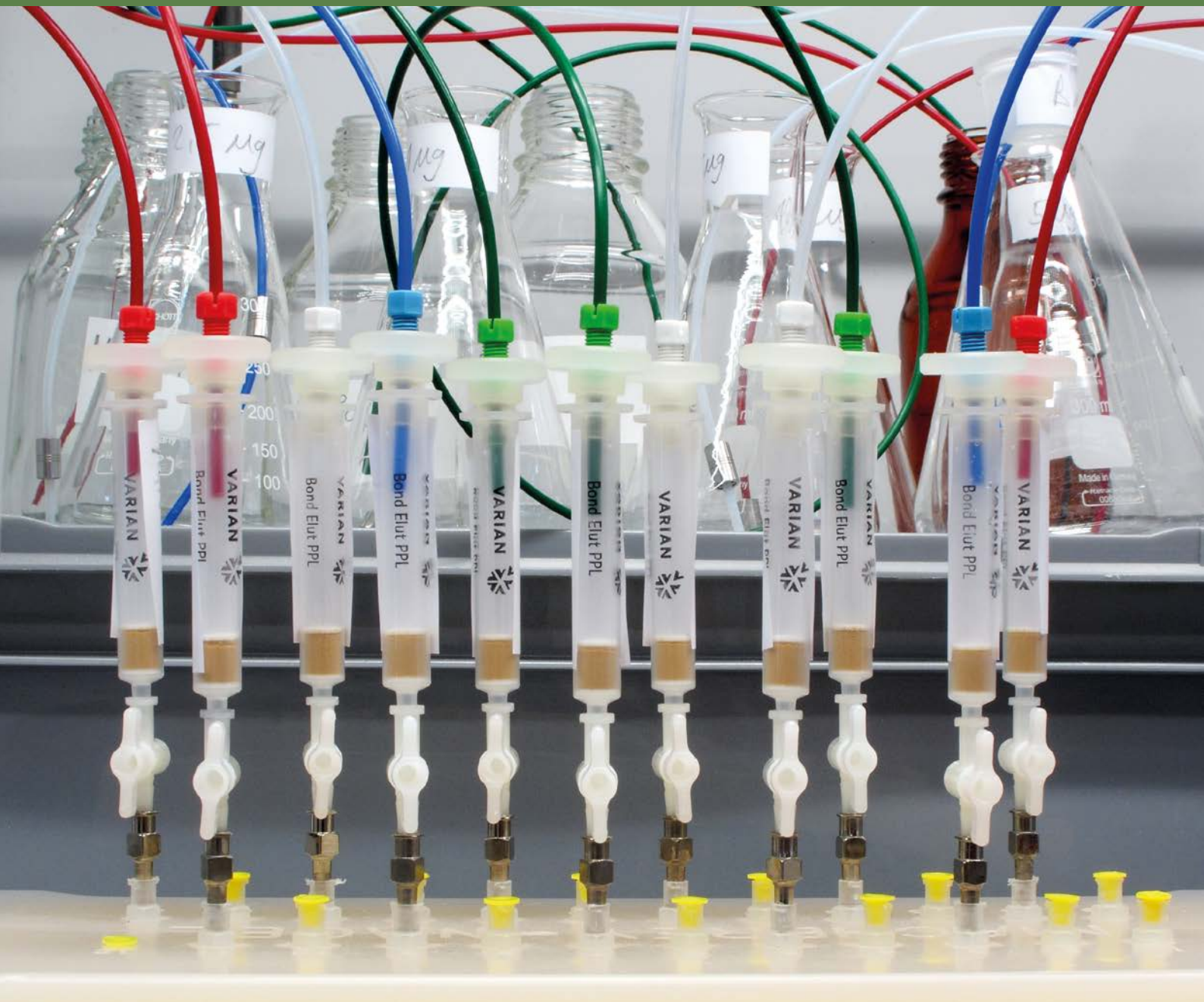
IBP

FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS IBP

BUILDING CHEMISTRY, BUILDING BIOLOGY, HYGIENE



“CURIOSITY IS ALWAYS THE FIRST STEP WHEN SOLVING A PROBLEM.”

GALILEO GALILEI

THE WORKING GROUPS

- CHEMISTRY AND SENSORY
- BIOLOGY
- TESTING
- CONCRETE TECHNOLOGY AND FUNCTIONAL CONSTRUCTION MATERIALS

are involved in the research of chemical, sensory, concrete-engineering-related, biological and hygienic problems occurring in relation to the interiors and exteriors of buildings as well as the insides of vehicles and aircraft. They provide consulting services for customers and develop new materials and analytical methods.

The focus is put on technical materials, components and construction products for indoor use, for buildings also materials and composites for external envelopes. For example, the scientists are involved in the research of emissions and eluates from materials, semi-finished products, end products and manufacturing methods, in evaluating odors by human olfactometry and subsequently identify the sources by chemical analysis. In addition, the department researches resistance against biological growth and infestation and is involved in microbiological examinations, for example, of mold and algae, which are of concern in the area of materials science and in the environmental media water, soil and air.

Moreover, existing materials, systems and system components are optimized, and new materials with more targeted functionality are developed. For example, functional surfaces, multi-functional materials and components, such as catalytic, self-cleaning or biostatic surfaces, bionic components, filter materials, sensors and sound-absorbing structural components.

Our employees analyze the mass transfer and absorption processes in materials and composite materials, such as filter media, catalytic converters and active construction components. They then measure and model the processes, incorporating material-specific, chemical and physical properties and realistic boundary conditions. They use this knowledge in the development of new analytical methods and are able to derive rapid tests which combine environmental simulations as well as chemical and microbiological problems to provide essential knowledge for the areas of ”Construction materials, construction components, buildings”, ”Vehicles and propulsion systems” and ”Aircraft, aircraft components”.

An additional emphasis of our work is the further development of concrete materials. For example, the addition of admixtures can increase stability, or research can be undertaken in order to find entirely new functionalities for the widely-used material.

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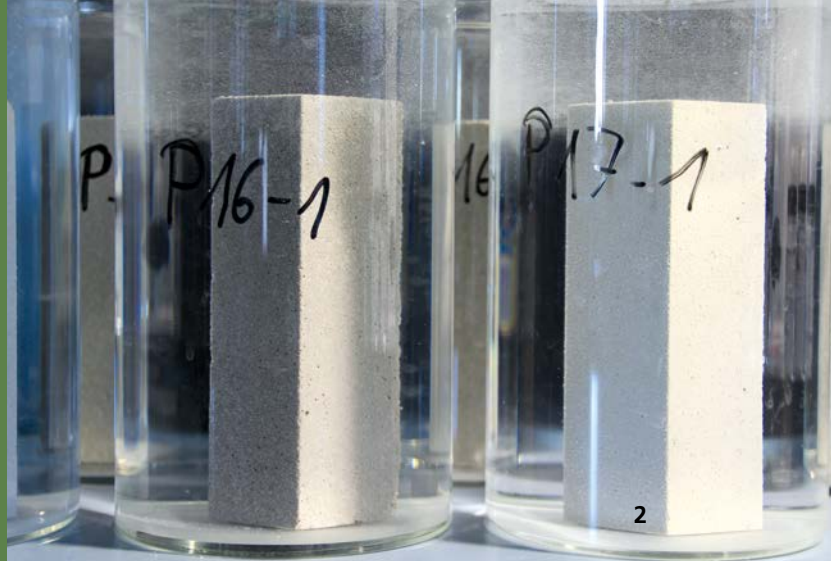

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CHEMISTRY AND SENSORY

Environmental characteristics and health evaluation of construction products for indoor use

Buildings and construction products must be as well-tolerated and environmentally compatible as possible, despite the variety of materials used to make them. The chemistry and sensory group tests the emission characteristics of construction products according to recognized methods and standards (e.g. according to AgBB).

Derived analytic methods for product development, third-party and internal monitoring

The recognized and standardized test procedures are often too time consuming for the examination of cases of damage or product development. Fraunhofer IBP is developing new rapid procedures (e.g. based on thermal extraction) in order to achieve fast determination of emissions and to enable the characterization of material changes.

Functional components and surfaces

Surfaces and components used indoors can be equipped with additional functions in order to e.g. facilitate improvement to air quality. The air exchange required is thereby reduced and heating energy can be saved. For this reason, we are developing and optimizing surfaces and structural elements that are equipped with absorbing and catalytic features. The development of super-hydrophobic and dirt-repellent surfaces with permanent effectiveness means that external areas can be better protected from the effects of water and soiling.

Indoor Air quality

People spend most of their time indoors. If well-being is affected, it is possible to perform an analysis of volatile organic compounds (VOC) and particulate emissions indoors and hence discover the structural causes of the complaints. Based on the results of this analysis, it is possible to make recommendations for the elimination of such causes.

Materials testing and materials analysis in cases of damage

Often the causes for damage to buildings are not to be found in the building itself. Thanks to the testing of faulty construction products at the laboratories of Fraunhofer IBP, it is possible to determine the precise causes of building damage and to provide recommendations for avoiding such problems in the future.

Ecological characteristics of materials and construction components

Many construction products today contain biologically active additives. The extent and effects of the release of such agents and additives on the environment can be examined in field tests under real climate conditions or by means of laboratory experiments. The results are used by the manufacturers for product development and for national and European standards.

Sustainability and durability of construction materials and buildings

Buildings should be economically and ecologically sustainable. In addition to the durability of construction materials, which can be determined by means of materials testing under genuine climate conditions in long-term field tests, the energy efficiency of buildings is also an important criterion. Fraunhofer IBP provides support in this complex area by means of developing both public and privately-funded organized certification systems.

Air quality inside buildings and in means of transport

The composition of indoor air is analyzed for its volatile organic compounds (VOC) and odor-active compounds. In order to identify and to quantify these substances, a combination of classic VOC analysis combined with methods of aroma chemistry (gas chromatography olfactometry, also known as GC-O or GC sniffing) – is used. The main objective is to localize the source of the emissions and to remove the most unpleasant malodors.


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Perceived air quality
The odor characteristics of construction materials, technical materials and raw materials, or of building and mobile interiors (car, aircraft), are evaluated by use of odor panels according to national and international standards and industrial guidelines.

Odor analysis and optimization
Malodors of technical materials and construction products are clarified according to the concept of molecular sensory analysis. The contained/emitted odor-active compounds in the product are extracted via solvent extraction or gas-phase extraction, and are analyzed via GC-O and gas chromatography – mass spectrometry (GC-MS), a weighting is carried out via dilution experiments and their chemical structure is elucidated. Based on this, it is possible to determine the origin of odorous substances from raw materials during production and, hence, it is possible to optimize manufacturing processes.

Analysis and optimization of taste
The structure of flavor-active substances, e.g. in drinking water transported in plastic pipes or stored in plastic bottles, is identified. These substances either migrate from the synthetic matrix or are first created upon contact with the water. The influence of environmental conditions, e.g. atmospheric pressure on odor and flavor perception, is examined.

New analysis technologies
Independent analysis methods are being developed for various problems, target components and ambient conditions. An internal method enables, for example, the rapid and precise identification and quantification of over 80 volatile aminoid compounds by means of high-pressure liquid chromatography, coupled with a triple quad mass spectrometer (HPLC-MS-MS).

Catalytic converter and filter technologies
The effectiveness of air-cleaning systems such as filters or chemically active absorber materials, for the reduction of VOCs, odorous substances, aerosols and dusts is subject to chemical analyses or even human olfactometry examinations and improved.

Intelligent air quality sensors / ventilation control
Appropriate sensors are being developed based on the knowledge of the composition of emissions (VOCs and odor-active compounds) indoors. The resulting signals can be selectively used to display the air quality and to intervene in the control of ventilation systems (demand-controlled ventilation).

Sensor-controlled process monitoring
The fermentation process in conventional bio gas facilities is currently hardly controlled. By using sensor detectable indicator compounds which are produced during anaerobic fermentation and which allow statements on the status of the fermentation process the process shall be monitored. Sensors will be developed to detect those compounds. Sensor signals shall be used to control the fermentation process.

BIOLOGY

Building and material pathology; microbiological building forensics
Materials and structures which are affected by undesired microbiological growth are subject to a detailed microbiological and ecophysiological anamnesis and diagnosis. A taxonomic classification is undertaken with the help of a unique collection of cultures containing material, construction component and indoor-relevant microorganisms, making use of traditional and molecular-biological methods. The results of this are evaluated from a hygienic point of view and clean-up and prevention strategies are developed, targeted at microbiological growth.

In addition to solid phases, such as construction materials and their surfaces, it is also possible to characterize liquids and gasses in terms of microbiology, for example, in water treatment plants (water-soil-air diagnosis).

Microbial safety
In the event of problems indoors, such as following water damage or in the case of health complaints, examinations are carried out regarding microbiological contamination (by biogenic aerosols, endotoxins, mycotoxins, etc.). Microbial contaminations in rooms as defined by hygienic safety can also be recorded

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1 *Determination of the linear thermal expansion coefficient of a ceramic sample by dilatometry.*
2 *Leaching test of plaster and mortar samples to determine the release of ingredients.*
3 *Odor analysis by means of gas chromatography olfactometry (GC-O).*
4 *Inoculated test specimen for isopleth measurement.*
5 *Mould covered material at the end of the test.*
6 *A newly discovered algae at Fraunhofer IBP: Excentrochloris fraunhoferiana.*
7 *An automobile interior part is put into a test chamber for emission testing.*
8 *Close-up view of a sound-absorbing concrete test specimen.*
9 *Different fractions from slag from waste burning plants after electrodynamic fragmentation.*

and characterized in the event of suspected intentional contamination ("bioterrorism").

Test methods; material-specific isopleth areas
For environment-hygiene evaluations, biological material tests are carried out according to standards, external specifications or even own independently developed standards. With the aid of a special experimental set-up, materials and material compounds are characterized according to the isopleth system and their natural resistance areas defined. Besides outdoor weathering experiments, short-term measuring methods are developed and applied. Test methods developed are actively incorporated into standards.

Sustainable materials and designs
Biological problems are dealt with in conjunction with new uses of sustainable raw materials and designs in construction. By determining application limits and resistance areas, the use of materials based on renewable raw materials in material composites and bio-composites, for example, are tested and designed.

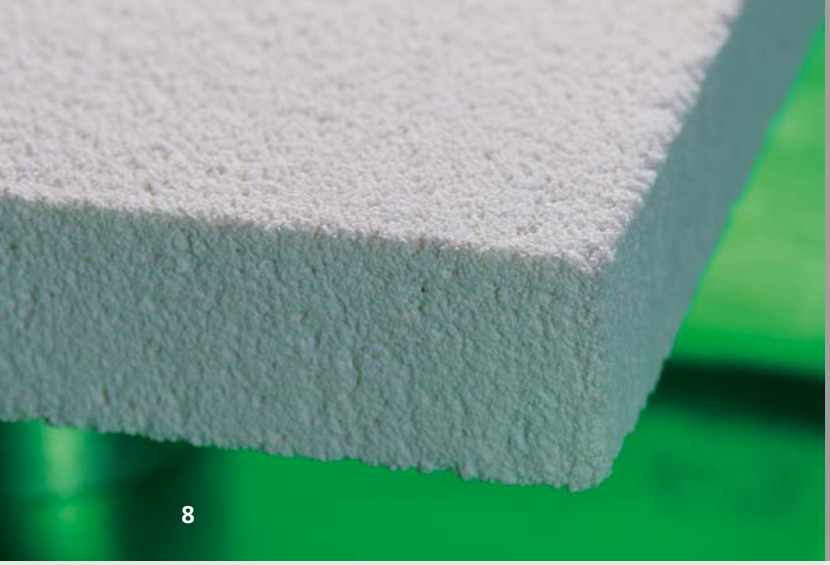
Fermentation processes
Model facilities for aerobic and anaerobic fermentation processes allow investigating monitoring systems to better control industrial plants. In the field of waste management the institute performs research on the energetic use of organic waste (bio gas facilities), also with regard to protection of people as well as on recycling by use of bio fermentation.

Application of biological principles to construction technology ("bionics"); biocontrol
Research is performed on intelligent materials such as self-cleaning surfaces, energy-buffered coatings by phase transitions, targeted radiation reflection, demand-controlled release of substances. Concepts regarding systems bionics are developed and investigated.

TESTING

Emission tests on materials
As part of material tests and material optimization for automotive industry, raw materials or so-called semi-finished products are analyzed by means of thermal desorption or thermal extraction and the amount of volatile organic substances (VOCs) is determined. For the test according to VDA 278, the laboratory has a DAkkS (German accreditation body) accreditation according to DIN EN ISO/IEC 17025:2005.

Emission tests on semi-finished products and structural parts
The organic emissions of the structural parts are determined in so-called SHED chambers (Sealed Housing for Evaporative Determination). A large number of chemical substance groups can be analyzed (VOCs, aldehydes, ketones, phthalates, amines, nitrosamines). These tests are carried out according to standards of the German Car Manufacturers Association (VDA), of European and Asian car manufacturers and according to the California Air Resources Board (CARB).



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Emission tests on car interiors
Solar radiation and summery temperatures heat up the surfaces in the interior of a car, releasing an increasing number of organic substances from the materials used in the interior. These emissions can impair the comfort and the well-being of the occupants of the car. These emissions can be identified and quantitatively determined in a special test bench for cars with sun simulation (FIEPS).

Measuring fuel emissions from propulsion systems
Fuel emissions are fuel vapors emitted into the environment via the air extraction system through microleaks, permeation or diffusion processes, e.g. from fuel lines or from the engine compartment. The emissions are subject to official regulations pertaining to maximum levels which must be guaranteed over a defined operating time (e.g. 15 years or 150,000 miles). At Fraunhofer IBP, emissions from fuel vapors from propulsion systems can be determined both qualitatively and quantitatively in unique test facilities. The objective is to optimize the materials and seals of the propulsion system in order to reduce emissions and to guarantee compliance with official regulations over the long term.

Special tests
SHED test chambers are also used, for example, to perform climate change tests or aging tests of structural elements and electrical devices such as from the field of medicine. Furthermore, analytical problems are addressed in the laboratory, such as analysis of amines, nitrosamines, phthalates, etc.

Accredited testing laboratory
Certain areas of the department are subject to accreditation according to DIN EN ISO/IEC 17025:2005 (registration number: DAP-PL-3743.30). The following tests are offered covered by this certification:

- evaluation of construction products according to the AgBB scheme
- test chamber tests and determination of organic emissions according to ISO 16000-6, -9 and -11
- thermal desorption according to VDA 278

CONCRETE TECHNOLOGY

Development of porous concrete
Keeping almost the same heat-insulating properties, the stability of porous concrete is to be considerably increased. By adding various solid admixtures to the low-viscous initial suspensions, the load-bearing capacity of the resulting porous concrete products are to be considerably increased. A porous concrete laboratory facility has been designed for this purpose: its objective is to guarantee both an extensive variation of the experimental parameters and the practical realization of the lab standard into production standard.

Sound absorbing concretes
Sound absorbers in granulated form may influence environmental conditions in rooms in a way that they increase health, well-being and productivity of human beings. They stand out due to high cost efficiency, good acoustical properties as well as sufficient strength. In addition their production is quite simple. We investigate the influence of the compressing process, distribution of grain size as well as the amount of binder on material properties of the sound absorbing material.

Simulation of fiber reinforced concrete in a workable condition
In cooperation with Fraunhofer ITWM, numerical simulation methods are developed which allow the depiction of fiber distribution and orientation in a test specimen on the computer. The aim of the computer-based prediction of the fiber distribution and orientation is to enable the design of new structural components which, due to improved fiber distribution and a smaller number of fiber misplacements, contain significantly fewer fibers.

Non-destructive detection of steel fibers in concrete
For the fully automated and production integrated determination of the amount, distribution and orientation of steel fibers in ready-to-use concrete parts a non-destructive testing system is developed. The basis for that is the method of active thermography. With this innovative test-

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ing technology production and quality assurance in ready-to-use concrete part industry shall be improved significantly to achieve cost reduction for steel fiber reinforced concretes.

Recycling by electrodynamic fragmentation

The processing of composite materials by mechanical methods results in crushing but not in separation into individual components. The so-called electrodynamic fragmentation enables a selective separation of composite materials into individual components by the use of ultra-short high voltage pulses. This method can be applied e.g. to old concrete to regain raw materials for cement industry and high value additives for concrete. From composite materials such as carbon-fiber-reinforced plastics fibers can be separated from the polymer matrix. This method is also applicable for the separation of complex waste mixtures as, for example, slag from waste burning plants or electronic scrap to supply valuable components like metals for reuse or further use. Selective separation by electrodynamic fragmentation is a promising alternative compared to existing processing methods for recycling.

Sustainable construction materials from waste materials

To reduce the consumption of non-renewable natural raw materials new technologies for integrating waste materials into the production process of sustainable concretes are being developed. That way new, lightweight, ecologic and cost-effective construction materials shall be developed from processed waste materials. Such materials stand out due to a low energy consumption as well as a low CO_2 output during production. In addition important parameters such as mechanical and insulating properties of the material shall be improved.

TEST LABORATORY

Accredited test laboratory according to DIN EN ISO/IEC 17025:2005 test facilities:

- biological lab with authorization according to IfSG (Protection against Infection Act)
- clean-air rooms with controllable temperature, humidity, air change
- emissions test chambers from 0.1 l to 7.5 m³
- thermal extractors
- HPLC-DAD, HPLC-MS-MS
- ATD-GC-FID-MS, GC-MS, GC-GC-MS, HS-GC-MS
- GCO-FID, GCO-GCO-MS
- ICP-MS
- hand held particle counter
- SMPS with water-CPC and electrostatical classifier
- thermal analysis: DSC, STA, TG, DIL
- comparative scale for odor evaluations according to DIN ISO 16000-28
- video, fluorescence, polarization and scanning electron microscopy (SEM)
- PCR-analysis
- isopleth test stand
- weathering facilities
- laboratory fermenters
- engine heat-up test stand
- car test stand with sun simulation
- porous concrete laboratory
- CDF/CIF-test equipment
- XRD, XRF
- lab-scale electrodynamic fragmentation facility

Tests according to:

- VDA 270, 275, 276, 277, 278
- AgBB scheme
- DIN EN 717-1
- CARB
- standard series ISO 16 000
- RAL-UZ (Blue Angel Label)
- company standards

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