CURRENT CHALLENGES

The demands on buildings today are manifold: apart from saving energy, the goal is also to meet growing hygiene and comfort requirements, as well as to focus more on using renewable energies and raw materials. Demands are also rising when it comes to damage prevention and the durability of building products. For planners and contractors, this means new challenges that cannot be mastered without in-depth knowledge of hygrothermal processes.

Our experts analyze the thermal and moisture properties of building materials, building components and entire building complexes – the basis for the optimized and needs-based design of new buildings and renovation projects. This includes ventilation systems and their interaction with the building envelope, as well as the influence of other hygrothermal storage masses.

With its long-standing practical experience and extensive network, the Fraunhofer Institute for Building Physics IBP not only helps its customers to work on and solve specific problems, but also to innovate new products and launch them on the market.

SERVICES OFFERED

- **Product manufacturers**
  - Joint product development and optimization
  - Investigation of product application possibilities
  - Determination of product durability and usability
  - Global marketing support through climate-specific product evaluation and international networks
  - Identification and evaluation of international trends in the building sector
  - Assistance in the use of innovative products and technologies

- **Planners and surveyors**
  - Help with building planning, damage analysis and selecting suitable retrofit measures
  - Planning tools and training courses
  - Advice on the use of innovative construction systems

OVERVIEW OF SERVICES PROVIDED BY FRAUNHOFER IBP

- **Hygrothermal system and materials testing**
  - We help you to develop systems and materials, as well as to ensure the quality of your products. We determine all the necessary features of materials and systems in order to identify possible uses and applications. This information is then used to optimize your product according to requirements and to ensure its usability and durability.

- **Hygrothermal system analyses**
  - Based on hygrothermal analyses, we develop solutions to improve hygrothermal comfort, as well as to reduce energy consumption and critical moisture conditions in buildings and entire city districts.

- **Climate simulation and field studies**
  - If testing new products and damage prevention measures, standard tests often reach their limits when it comes to realistically assessing resistance to weathering and functional reliability. We test your products outdoors under real conditions and in the laboratory under extreme conditions.

- **Climate-adapted market implementation**
  - Taking local requirements into account, we help you launch new products across the globe. Especially when using renewable or recycled building materials – particularly in other climate zones – a detailed hygrothermal analysis is indispensable.

“Don’t end up in deep water – rely on hygrothermal know-how!”

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“Energy efficiency, hygiene, comfort and durability are the key to sustainable construction.”

HYGROTHERMAL TESTS OF SYSTEMS AND MATERIALS

The suitability and durability of innovative systems and materials depend crucially on their ability to function flawlessly and provide adequate protection against weather and environmental influences. In our hygrothermal laboratories, we test not only transparent and opaque building components but also high-performance sealing and insulation systems, plasters and paints. Our tests are not limited to building products: they also include exposed technical enclosures and casings as well as transport packaging.

Particular requirements have to be taken into account when it comes to new materials and those based on renewable raw materials, as well as when using protective systems. Consequently, detailed knowledge of the properties of systems and materials is key in order to guarantee product success.

Consumers rightly expect thermal and moisture protection systems to meet requirements over their entire service life. Manufacturers therefore have to develop, select and implement the right products, and ensure the compliance of their products through continuous quality control.

Our Services

- We test the thermal, hygro and radiation properties of your products, as well as their impermeability to air and rain.
- The profiles of the properties ascertained form the basis for further investigations – for example, computational simulation models. We identify in advance the climatic parameters that will stress products the most and thus determine their durability and suitability for use.
- Based on this, we then determine their possible uses and scope of application.

Application project

Green roof constructions

- For further information, please see page 14.

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Resistance to weathering and functional reliability are essential factors when it comes to assessing the cost-effectiveness and sustainability of products. However, when evaluating new products or the changed use of existing products, standard tests often reach their limits. They are also rarely suitable for assessing product performance under extreme conditions.

In such cases, climate simulation, i.e. subjecting products to simulated stress due to changing climatic conditions, or field studies are appropriate testing methods. The combination of these methods enables reliable conclusions to be drawn regarding the suitability and durability of a product under various conditions of use and serves as a basis for:

- assessing a product’s resistance to weathering and usability
- researching the hygrothermal properties of materials and systems under various climatic conditions and validating model concepts
- developing products to protect against extreme climatic conditions

Our Services

- We test your products under real-life conditions. Field studies provide the most reliable information because the tested product is exposed to all natural factors.
- Alternatively, we can subject your products to even more extreme climatic conditions in our climate chambers. By selecting specific climate cycles, we can accelerate the natural aging process of certain products.
- In addition, we also offer you our expertise when it comes to numerically simulating the performance of materials and building components.

Application project

Proof of the suitability of multilayer-effect glazing

For further information, please see page 14.
HYGROTHERMAL SYSTEM ANALYSES

By considering all the boundary conditions that determine the interaction between the outdoor climate, building envelope and interior, a detailed analysis can be made of the energy requirements, indoor climate and hygrothermal conditions inside the building envelope. Besides recording and assessing factors such as internal sources of heat and moisture, air exchange and weather data, the tests also examine user patterns and the use of ventilation systems in different climate zones.

Conversely, the effects of a building on its immediate surroundings and thus on the urban climate can also be extrapolated. Our experts use the knowledge gained in this way to develop and implement simulation tools.

Application project
Urban Climate Under Change
→ For further information, please see page 15.

Our Services
→ When insulating the building envelope and ensuring targeted ventilation, it is particularly important to avoid moisture damage. We provide own specially developed simulation tools for this.
→ We also offer special programs for evaluating and designing entire buildings with regard to their moisture behavior and energetic performance. By linking these aspects, conditions in rooms and building components can be taken into consideration at the same time.
→ We develop measures to ensure a stable climate, thus meeting the conditions required by historical buildings, as well as by museums or depots where sensitive goods are stored.
→ We also analyze the effects of buildings and infrastructures on the microclimate in urban environments and identify solutions for improvement, such as water-retaining surfaces or green areas.

“Intelligent moisture management is essential to prevent damage to buildings and conditions that pose health risks.”

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YOUR CONTACT
Current and future developments in the construction industry are characterized by the growing use of renewable energies and building materials made from renewable raw materials. At the same time, the industry is also becoming increasingly globalized, since the focus of new construction activity has long since shifted from industrial nations to threshold countries.

This is accompanied by the rising importance of moisture control issues, such as resistance to weathering, aging, hygiene and damage prevention. This presents manufacturers, planners and contractors with new challenges that cannot be mastered without in-depth knowledge of hygrothermal interrelationships.

Against this background, the Fraunhofer IBP not only offers manufacturers and architects support in solving specific problems, but also passes on the latest scientific findings in the form of seminars, workshops and lectures held around the world.

“Climate and use determine the hygrothermal requirements of a product – we offer you our know-how for this purpose.”

**Our Services**

- As a rule, the building product requirements that apply to Germany cannot easily be transferred to other countries. For this reason, we provide you with assistance when launching your products onto the market in other climate zones.
- Thanks to our extensive global network, we not only identify new applications for building products but also establish contacts with authorities, testing institutes and companies abroad.
- We help you develop or optimize building materials that are based on renewable or recycled raw materials.

**Application project**

**Risk-free interior insulation**

- For further information, please see page 15.

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FastDry Technologies™
The FastDry Technologies™ module has been developed to dry wet walls. The combination of a heating element with vapor-permeable insulation, which are placed together in a single module directly on the wet wall, enables walls to be dried quickly and in an extremely energy-efficient manner. In many cases, the amount of energy required to dry a wall can be significantly reduced, sometimes by up to 90 percent.

VALEA
The indoor climate analysis platform at mmc automation GmbH contains a methodology developed by Fraunhofer IBP. The platform analyzes the measured indoor climate and protects the user and the building from damage. In contrast to other solutions currently available on the market, the system not only incorporates current measured values but also learns the more it is used.

TEST ENVIRONMENTS

Climate simulation
- A series of climate chambers with programmable temperatures and humidity levels that are used, for example, to test building components and ventilation equipment under varying conditions
- Equipment for testing long-term resistance to driving rain
- Solar simulator for investigating the behavior of building components exposed to radiation

Field test site
- Full-scale outdoor building physics test rigs
- Versatile test bench to evaluate flat and pitched roofs
- Climate-controlled test bench with removable wall elements to assess the resistance of facade to weathering
- Facilities for testing perimeter and floor slab insulation systems

Laboratory for determining diverse heat and moisture parameters
- Thermal and radiation laboratory equipment
- Test benches for subjecting materials to moisture and mechanical stress

SOFTWARE DEVELOPMENTS

Building component simulation
DIN 4108-3 prescribes a moisture control assessment by means of hygrothermal simulation for many building structures. This hurdle is easily overcome using the WUFI® Pro software developed by Fraunhofer IBP.

Building simulation
The WUFI® Plus software simulates not only hygrothermal conditions in building components but also the indoor climate. It can therefore also be used to assess comfort and energy requirements.

Passive house design
The WUFI® Passive software combines the features of dynamic simulation with the energetic monthly balance procedure to design and validate passive houses. In the USA, our software is the exclusive standard tool for certified passive house consultants.

All the programs of the WUFI® software family are available from the website: www.wufi.de

Urban climate simulation
In times of climate change and increasing urbanization, it is becoming increasingly essential to develop cities in a sustainable and climate-friendly way. Using dynamic urban climate simulations, we help cities and municipalities to plan urban spaces that are fit for the future.
Simulations carried out using them were validated in field laboratories as part of a research project. The hygrothermal parameters of the substructure and greening layers can help. This requires detailed knowledge of the moisture standard cannot be applied, only a hygrothermal simulation method according to the German moisture protection process in summer. Therefore, designing a green roof requires particularly careful hygrothermal planning. Since the Glaser damp over time and, in the case of wooden roof constructions, the comparatively cool top layer impairs the re-drying can help. This requires detailed knowledge of the moisture parameters of the substructure and greening layers. These parameters were determined in the Fraunhofer IBP test laboratories as part of a research project. The hygrothermal simulations carried out using them were validated in field studies in Germany, Austria, Italy and Portugal. As a result, green roofs can be reliably planned for all construction types and climate zones.

**Areas of Expertise**

**Application Projects**

**Green Roof Constructions**

A green or vegetated roof not only turns a sealed surface into a habitat for plants and insects but also helps to combat the so-called “heat island” effect through evaporation and reduce flood risks by retaining water. For this reason, green roofs are becoming more and more popular and are often encouraged or demanded by local authorities.

However, these positive aspects are also offset by risks. For example, inverted roof insulation under a green roof becomes damp over time and, in the case of wooden roof constructions, the comparatively cool top layer impairs the re-drying process in summer. Therefore, designing a green roof requires particularly careful hygrothermal planning. Since the Glaser method according to the German moisture protection standard cannot be applied, only a hygrothermal simulation can help. This requires detailed knowledge of the moisture parameters of the substructure and greening layers. These parameters were determined in the Fraunhofer IBP test laboratories as part of a research project. The hygrothermal simulations carried out using them were validated in field studies in Germany, Austria, Italy and Portugal. As a result, green roofs can be reliably planned for all construction types and climate zones.

**Proof of the Suitability of Multilayer-Effect Glazing**

Visible from afar, the Atakule Tower is one of the landmarks of the metropolis of Ankara with a population of five million. A modern shopping and entertainment complex is being built directly at the foot of the tower to the tune of over 40 million euros. So-called shadow boxes are planned as design elements in its facade. These consist of transparent panes of glass enclosing a sealed volume of air behind.

Our team of scientists was asked to perform suitability tests on this innovative facade construction and to observe its deformation behavior under changing climatic conditions. For this purpose, a site-specific test program was defined together with the facade planning company and carried out at the Fraunhofer Institute for Building Physics IBP.

Fraunhofer IBP has developed a special radiation-permeable climate envelope with a particularly powerful air-conditioning unit and digital process control technology. Thanks to this, the temperature of a facade element measuring more than five square meters in size and four and a half meters in height could be cyclically conditioned between −15 and +40 °C with pinpoint accuracy. During the “day”, in addition to controlling the temperature, the unit also provided full-surface artificial sunlight with an irradiation of 900 W/m², causing the glazing to reach a temperature of almost 80 °C.

For several weeks during the total climate exposure period, not only the temperatures of the components but also their deformation behavior was recorded by ultrasonic sensors at selected measuring points. By analyzing this data and performing regular visual checks, the planning office and the façade construction company carrying out the work had a reliable database at their disposal for verifying the design concept.

**Risk-Free Interior Insulation**

Interior insulation is often the only way to improve the energy efficiency of older or listed buildings. The fear of condensation problems remains constant – even though it already been proven time and again that moisture issues are not to be expected if interior insulation is designed correctly. In fact, interior insulation not only reduces energy requirements but also improves thermal comfort and hygienic conditions in rooms.

To give planners and contractors detailed information about internal insulation requirements and conditions of use, our researchers have worked together with other research institutions and manufacturers of insulation materials to develop a guideline for insulating the interior surfaces of external walls. The contents of this guideline are largely based on laboratory and field tests at Fraunhofer IBP, as well as on extensive computational parametric studies on a number of interior insulation systems under various indoor and outdoor climatic conditions.

The knowledge gained has also been incorporated into various international guidelines – e.g. into guidelines of the International Association for Science and Technology of Building Maintenance and Monuments Preservation e. V. and in the French RAGE regulations (RAGE = Règles de l’Art Grenelle Environnement). This makes it easier to market such systems and guarantees building owners and architects higher reliability when it comes to selection and planning decisions.

**Urban Climate Under Change**

Cities are highly sensitive to climatic changes but only adapt at a very slow pace. Action must therefore already be taken today in order to prepare cities to cope with the anticipated consequences of climate change. Scientists at Fraunhofer IBP are currently testing efficient urban climate models, which form an important basis for future planning decisions.

The aim is to develop and validate a user-friendly urban climate model and to test its suitability for use in practice. This tool will allow analyses to be made across all sectors and to plan measures that will reduce air pollution and improve urban climates.

The potential range of application is extensive: It can be scaled to examine single buildings through to entire neighborhoods and city districts and even large cities such as Berlin. Typical urban climate issues, such as wind or thermal comfort, can be addressed, and the spread of pollutants and many other aspects can be simulated.

**Photo Acknowledgements**

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