FIW Annual Report 2017

FIW München

Forschungsinstitut für Wärmeschutz e.V. München

Inhalt

Title Image: device for measuring the maximum service temperature

1 Editorial

An eventful and moving year of 2017 with ambitious goals in the area of German energy and climate policy is now behind us. At this point we do not wish to discuss the 2018 coalition agreement between the parties in the German government.

In addition to many other important tasks which are discussed in our annual report and also due to the rules of procedure that were adopted almost 100 years ago, we remain strongly committed to the currently relevant societal goals, which, among others, are based on the fact that "Thermal insulation is equivalent to protecting our resources and climate." This is something that we will continue to contribute to.

The goal of making all buildings climate-neutral by the year 2050, for example, isn't just a political goal, it is a socially defined goal at the same time. And it is one in which the individual and the very varied interests of millions of private, commercial and governmental owners of buildings find equal consideration. In this respect, considerable importance and responsibility is attributed to scientific knowledge and practically-oriented experience.

In the scope of the study into buildings which we completed together with the Institute for Technical (ITG) in Dresden and ewi Energy Research & Scenarios and with which we were contracted by the German Energy Agency (dena), entitled "Scenarios for a market-economic climate and resource protection policy in the building sector for 2050", we compared various paths for the achievement of the goals which we looked into from the perspective of factors such as costs, energy imports and infrastructure requirements. This showed clearly that a "business as usual" strategy will not be sufficient for even getting close to achieving the climate protection goals in the buildings sector.

The good news, however, is that achieving the climate protection goals by 2050 is possible from both the technological and financial perspective. To achieve these goals, however, we will have to work harder and do more than we have so far. The necessary technology is already widely known and tried and tested. The energy transition in the buildings sector and the necessary action in the field of climate protection will be realized in the best way if all of the available efficiency technology is used and applied on a cost-effective basis.

One of the key results of the study is that by 2050, significantly more buildings must be given an energy-related upgrade each year. The considerable potentials for saving CO_2 emissions and energy are to be finally mobilized. Anyone who has followed the developments in recent years will be aware that a refurbishment rate of even 1.5 percent is an ambitious goal. There is no lack of good intentions from the worlds of politics and business. Despite this, until now, we have achieved considerably less than one percent per year. This has several reasons and causes.

It is necessary to point out the relevance of the time frame. The year 2050 may be dismissed because it is too far in the future. Yet that isn't a wise approach. 2050 is a goal which can only be achieved if action is taken in the here and now – which means this legislative period. Taking action means that in comparison with the status quo, the energy-related upgrades must be increased by at least 40 to 50% as quickly as possible. This not only requires broadly based approval at the level of our society, but also the necessary political will. The key requirement is to achieve a reduction in our use of energy.

We need to stop focusing on the use of specific technologies (such as electrification). The triple approach, consisting of increasing the levels of efficiency, the direct use of renewable sources of energy, and forging links between sectors, is the key to success. Investments in modernizing buildings' use of energy as well as efficient systems technology which is based on renewable sources of energy provide the basis for achievement of the climate goals, i.e. an approach that is more open to technologies.

In the future, buildings will also be increasingly important for the energy system because they will create and store energy. To tap into such potential, for the very heterogeneous and small-scale buildings sector, we require open technology paths which take factors such as affordable pricing, security of supply and acceptance on the part of the population into account.

So far, it is evident that the energy transition has led to high costs and has not increased the security of supply. In fact, it has set a huge redistribution mechanism in motion. Furthermore, it is common knowledge that the transformation of the buildings sector is of decisive importance for the energy transition and the achievement of the climate policy goals: in Germany in the year 2015, of some 2,466 TWh of final energy, 779 TWh was used for heating purposes in the buildings sector (BMWi 2017) alone, which is more than the areas of both transportation (766 TWh) and industry (493 TWh).

This makes it increasingly clear that buildings won't just play an increasingly important role in the future, but that the requirements surrounding energy and climate policy will also make it necessary to bring about an improvement in the framework conditions for investments in the energy efficiency of buildings and to make use of the need for action which exists along the entire value added chain.

These are considerable tasks. All gesture politics aside, huge efforts remain necessary to take such action in the new legislative period.

In the interests of our members and customers, and on the basis of the know-how we have gathered, the available scientific knowledge and an updated standard of quality, this is action to which we will remain completely committed.

Klaus-W. Körner
Executive chairman
of FIW München

Prof. Dr.-Ing. Andreas Holm
Managing institute director

2 FIW München at a glance

FIW München sees itself as driver for innovation and has a leading role in the new and further development of elaborate methods in the area of energy efficiency, both in buildings as well as in industrial applications. In these areas, the direct charitable purposes of the registered association concentrate on the development of new technologies, processes, applications and services. The statutory purposes are particularly achieved by:

- Research in the area of heat and mass transfer, in particular the scientific principles concerning insulation against heat and cold;
- The dissemination of these findings;
- The thermal testing of construction and thermal insulation material and the constructions produced with them (practical designs);
- The cooperation with associations of heat economy, technical associations and scientific institutes.

Managing institute director:
Prof. Dr.-Ing.
Andreas Holm

Research and development on thermal insulation

Christoph Sprengard

Service

Quality Management
Ralph Alberti

Equipment building
Michael Guess

Administration
Rolf Opp

Certification

Wolfgang Albrecht

Surveillance

Testing

Claus Karrer

Roland Schreiner

In the framework of their activities according to Landesbauordnung [regional building regulations] and the EU Construction Products Regulation, the executive staff of the certification body, inspection body and test body is exempted from the instructions of the institute management with respect to their professional fields.

Core competencies and business areas

The structure and organization of FIW München is oriented at both the business areas as well as at the classic core competencies. The core competencies and the business areas of FIW cover a broad spectrum. Among others, the areas of laboratory tests, field tests, the development of measuring devices, in-situ demonstrations, studies, training and standardization are covered.

Core competencies and business areas

Testing, monitoring and certification

Holistic evaluation of the building shell

In all questions pertaining to

- thermal insulation
- moisture protection
- fire protection
- stability
- material composition

Development of testing standards, material standards, guidelines and worksheets

Research and development

Basics of thermal insulation and moisture protection as well as construction chemistry

Testing of technologies and new materials for improving energy efficiency

Effect of determining factors

Durability of materials and systems

Initial research into construction material and construction system development

Energetic optimization of the complete building system

Transfer of knowledge and technology

National and international standardization

Member of various expert committees

Publications and lectures

Realization of training sessions and symposia

Development of measurement devices and testing equipment (scientific system and equipment building)

Building industry

Insulation of industrial systems and in industrial construction

Transport and logistics

2 FIW München at a glance

Financial and staff development

In the financial year of 2017, the FIW e.V. München generated revenues amounting to EUR 7.94 million (previous year: EUR 8.42 million). The early adaptation of the institute's range of services progresses further: The turnover generated with voluntary inspection systems is increasing since more and more manufacturers and (end) customers appreciate the quality-assured application of high-end products. The areas of testing and inspection as well as research and development have adapted to the increasing variety of the insulation material and insulation systems to be examined.
With almost EUR 0.4 million, the investments were at the level of the previous year (EUR 0.5 million); here, numerous projects could not be started because of capacity constraints and were rescheduled to 2018, analogously to the planned construction work.

The growth in staff of the last few years (cf. image) was not continued in 2017. In view of the order situation, the core staff remained almost on the same level as in the year before. At the end of December 2017, 67 (previous year: 66) employees worked in the institute's business premises, which corresponds to a full-time equivalent of 64 (previous year: 64).
FIW München offers their employees long-term employment and development opportunities. The fact that this is highly appreciated is proven by the general satisfaction of the employees of the institute and by the low fluctuation. This loyalty of our employees who significantly contribute to the success of the institute, the preservation of competence and experience is a great appreciation of the employer and also an aspiration.

The following employees celebrated their anniversary at the institute in the past financial year:

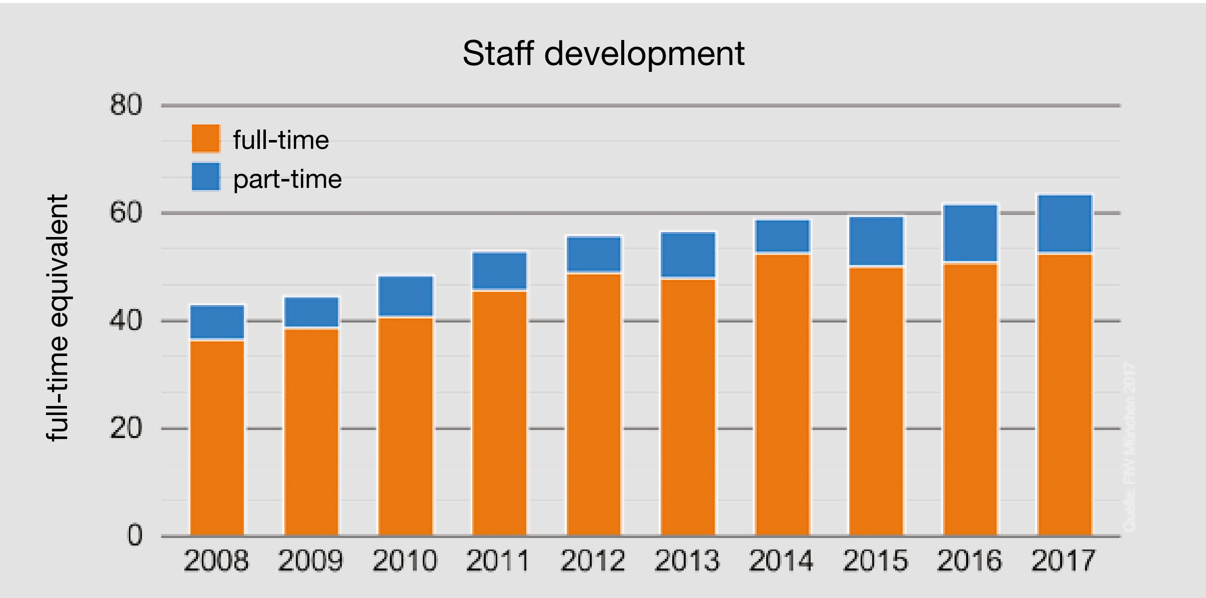
Service anniversary

10 years
Maria Bernthaler
Alexandra Köhler

15 years
Sidonia Tana

20 years
Ralph Alberti

25 years
Stefan Hupfauer



Memberships and cooperations

FIW München is a member of the following institutions:

- Advanced Porous Materials Association „AdvaPor“, Strassburg
- Allianz für Gebäude-Energie-Effizienz (geea) [alliance for building-energy efficiency], Berlin
- ASTM International, Philadelphia
- Connect Deutschland e. V., Aschheim
- BDI – Initiative „Energieeffiziente Gebäude“ [initiative for energy-efficient buildings of German federal association of the industry sector], Berlin
- DIN Deutsches Institut für Normung e. V. [German standardization institute], Berlin
- Deutsche Energie-Agentur GmbH (dena) [German energy agency], Berlin
- Deutscher Kälte- und Klimatechnischer Verein e.V. (DKV) [German association for refrigeration and air conditioning technology], Stuttgart
- Deutscher Verband für Materialforschung und -prüfung e. V. (DVM) [German association for research and testing of materials], Berlin
- EAE - European Association for External thermal insulation composite systems, Baden-Baden
- Energy Efficient Buildings Association E2BA, Brussels
- Fachverband Gebäude-Klima e. V. [German professional association for air conditioning and ventilation systems], Bietigheim-Bissingen
- Fachverband Luftdichtheit im Bauwesen e. V. [German professional association for airtightness in the construction sector], Kassel
- Fachverband Innendämmung e. V. [German professional association for internal insulation], Frankfurt am Main
- Forschungsgesellschaft für Straßen- und Verkehrswesen [German road and transport research association], Cologne
- Gesellschaft für Rationelle Energieverwendung e.V. (GRE) [German association for rational energy use], Kassel
- Industrie-Förderung GmbH, Berlin
- L’Institut International du Froid (IIF), Paris
- Technischer Überwachungsverein Bayern e.V. (TÜV) [Bavarian technical inspection association], Munich
- Vacuum Insulation Panel Association (VIPA International), USA
- Vereinigung der bayerischen Wirtschaft e. V. (vbw) [Bavarian industry association], Munich; (supporting member)
- VMPA Verband der Materialprüfungsanstalten e. V. [German association of material testing bodies], Berlin
- Verein zur Förderung der Normung im Bereich Bauwesen e. V. VFBau [German association for promoting standardization in the construction sector], Berlin
- Deutsche Gesellschaft für Holzforschung e.V. [German association for research in wood materials], Munich

Additionally, we have concluded cooperation agreements with Deutsche Energie-Agentur GmbH (dena), Berlin, and the Munich University for Applied Sciences.

Abb. 1 dena-Event Brussels

Testing and inspection

In the conventional, national compliance assessment of construction materials, the necessary tasks are separated into the tasks of the testing body for conducting product tests, the tasks of the inspection body for audits and sampling in the manufacturing factory as well as the tasks of the certification body for the assessment of the test and audit results and the granting of compliance certificates. This procedure, which is regulated in the Landesbauordnungen (LBO) [regional building regulations] of the German federal states, will only apply to a small number of thermal insulating materials without European product standard or European technical assessment (ETA) in the future.

The conformity assessment of construction material according to the Construction Products Regulation, or CPR, does not provide for the institution of an inspection body. All tasks are assumed by a certification body and a testing body; here, the responsibility of the national inspection body, i.e. the auditing of manufacturing facilities and sampling, are allocated to the certification body. However, the latter has the option of commissioning other bodies, e.g. the testing body, with the implementation of some tasks. The employees of the testing body commissioned with the management of insulating material manufacturers thus often work in the same manufacturing facility and with respect to the same insulating material, in their own responsibility, as employees of the supervisory body according to LBO and at the same time as employees of the certification body according to the European construction products directive. On the other hand, the employees of the certification body according to CPR may also assume tasks of the inspection body in the manufacturing factory according to Landesbauordnung. However, they are always the competent contact persons for any questions with respect to quality assurance and conformity verification of thermal insulating materials on a national or European basis.
This is of particular relevant in view of the fact that, according to the decision of the European Court of Justice in the legal case C-100/13, thermal insulating materials with European regulation basis may no longer be further regulated on a national level and thus the testing and, if applicable, certification by a European notified body has become even more important. On the other hand, the supreme construction authorities of all German federal states have stipulated in their resolutions for the enforcement of the CPR that for the presentation of a building authority requirement level, general approvals by the supervisory building authority may still be used provided that their ancillary provisions, i.e. the compliance with the factory production control and the external control by an inspection body approved as per LBO, are met. In the future, there will thus be more overlapping between the tasks of the inspection body according to LBO and the notified certification body. In particular, this applies to the implementation of voluntary certification programs by the accredited certification body of FIW München.
The test body aims at offering all tests that are relevant to thermal insulating materials or, in exceptional cases, mediate them through cooperations with other qualified bodies. The decades of experience of the largest testing body for thermal insulating materials in Europe are integrated in the relevant standards through the cooperation in national and international committees. In return, new testing procedures are implemented in time and in a competent manner in FIW München and offered to the manufacturers for the verification of their product's suitability.
FIW München is recognized both on a national (notified test body, inspection body and certification body) as well as on a European (notified body) level and accredited as testing laboratory according to EN ISO/IEC 17025. This special competency is shown by the leading participation in the "Lambda Expert Group" for the voluntary European certification system (CEN KEYMARK), in which the registered laboratories audit one another for determining the thermal conductivity of thermal insulating materials and confirm the measurement accuracy through cooperative testing. In the area of technical insulating materials, the characteristics on which the laboratory group focuses are expanded to include the determination of the maximum application temperature and the water-soluble chlorides. We are particularly proud of having been able to find a reference material (expanded glass granules) for securing the European level of thermal conductivity towards higher temperatures.
In the specialist field of "technical insulations", the testing body offers thermal insulation and mechanical testing in the expanded temperature range from -180°C to +1000°C. The laboratory tests carried out according to the European testing standards are supplemented by the determination of impact parameters of applied insulation under practical conditions, e.g. on boiler walls, in pipelines or under oscillation load. In addition to the commissioned tests for all technical insulating materials, the active design of the European voluntary quality assurance (VDI/KEYMARK) is an important offer for our customers. The participation in cooperative testing is a fixed component of the work of the accredited laboratories of the testing body.

Test facilities and equipment

In the framework of the energy efficiency of buildings and technical systems, material testing, certification and quality assurance become increasingly important. In addition to our research and development work, we operate testing laboratories in accordance with the highest quality standards and have decades of experience with a great reputation. We have the latest examination possibilities as well as numerous analysis technologies. Due to the increased demand for corresponding tests, our testing laboratory is continuously expanded both with respect to instruments as well as with respect to staff. Currently, FIW München has the following testing equipment:

Test facilities for insulating materials in technical applications

Product Type Determination (PTD) according to EN 14303 - 14309, EN 14313, EN 14314

Thermal conductivity of insulating materials according to the testing regulations DIN EN 12664, DIN EN 12667, ISO 8301, ISO 8302, ASTM C 177, ASTM C 518 and the regulations of DIBt, Berlin

- in the temperature range of -180 °C to 900 °C
- At a mean temperature of 10 °C
- At a mean temperature of 40 °C

Thermal conductivity of pipe insulation materials and pipe insulation and pipeline systems according to the specifications of DIN 52613, DIN EN ISO 8497

- In a temperature range of -70 °C to +300 °C mean temperature
- at 10°C mean temperature for cold insulations
- at 40°C mean temperature for insulating materials for insulating heating systems
- at 50 °C mean temperature for district heating piping

Dimensional stability / shape retention

- Dimensional stability under constant normal laboratory conditions according to DIN EN 1603
- Dimensional stability under specified temperature and humidity conditions according to DIN EN 1604

Performance under higher temperatures

- Maximum service temperature according to DIN EN 14706 and DIN EN 14707
- Maximum service temperature with and without oscillations

Measurements of the heat transition and the temperature field with standardized and special measuring and testing equipment on

- Insulation systems
- Building components

Requirements range for fire protection/fire performance of construction material

- Non-combustibility test according to DIN EN ISO 1182
- Gross heat of combustion (calorific value) according to DIN EN ISO 1716
- Ignitability with direct flame exposure according to DIN EN ISO 11925-2

Mechanical characteristics

- Condition, dimensions, apparent density according to DIN EN 1602 and DIN EN 13470
- Tensile strength according to DIN EN 1607, pull-of-resistance, transverse tensile strength
- Deformation under defined compressive load and temperature conditions according to DIN EN 1605
- Compression behaviour according to DIN EN 826
- Shea behaviour according to DIN EN 12090
- Bending behaviour according to DIN EN 12089
- Behaviour under point load according to DIN EN 12430
- Coefficient of thermal expansion according to DIN EN 13471
- Compressive creep according to DIN EN 1606

Hygric characteristics and frost performance

- Water absorption by full immersion according to DIN EN 12087
- Water absorption with temperature change 20°C/40 °C
- Water absorption by diffusion at 50 °C / 1 °C according to DIN EN 12088
- Water absorption with partial immersion according to DIN EN 1609
- Moisture content according to DIN EN 322
- Water vapor transmission properties according to DIN EN ISO 12572, DIN EN 12086 DIN EN 13469

Other characteristics

- Volume percentage of open cells and of closed cells according to ISO 4590
- Cell gas composition with a gas chromatograph
- Chloride content and determination of the pH value according to DIN EN 13468

3 Testing and inspection

- Thermal stability
- Airflow resistance according to DIN EN 29053
- Non-fiber components (melting beads)
- Organic content according to DIN EN 13820
- Fibre diameter
- Determination of the absence of silicone in insulating materials

Acceptance measurements

- In-situ measurements with thermal flow sensor and/or infrared camera

Test facilities for insulating materials in building construction

- Product type determination (PTD) for thermal insulating materials according to EN 13162 – EN 13171
- Approval tests for new insulating materials according to the test plans of the DIBt
- Initial testing for thermal insulating materials according to test plans of the DIBt for type approval certificates or according to the European Assessment Document (EAD)

Fire performance and smouldering/glowing

- Classification of the fire performance according to DIN EN 13501-1, class E
- Ignitability of products with direct flame exposure according to DIN EN ISO 11925-2
- Verification of the construction product class DIN 4102-B2 (normal flammability)
- Determination of the propensity to undergo continuous smouldering according to DIN EN 16733

Testing the thermal conductivity of construction and thermal insulation products according to testing regulations as per DIN EN 12664, DIN EN 12667, DIN EN 12939, ISO 8301, ISO 8302, ASTM C–177 and the provisions of DIBt, Berlin

- in a temperature range of -30 °C up to 80 °C mean temperature
- At a mean temperature of 10 °C

Mechanical characteristics

- Condition, dimensions, thickness, apparent density
- Thickness for floating floor insulating products according to DIN EN 12431 (compressibility)
- Tensile strength, pullo-of-resistance, transverse tensile strength (DIN EN 1607/1608)
- Compression behaviour according to DIN EN 826
- Shear behaviour according to DIN EN 12090
- Bending behaviour according to DIN EN 12089
- Behaviour under point load according to DIN EN 12430
- Dynamic stiffness according to DIN EN 29052-1
- Coefficient of thermal expansion according to DIN EN 13471
- Slump after vibration
- Slump after climate testing 40 °C / 90 % r.h.
- Long-time creep behaviour under compressive stress according to DIN EN 1606 up to a thickness of 300 mm
- Dowel pull-through strength according to ETAG 004

Hygric characteristics and frost performance

- Water absorption by full immersion according to DIN EN 12087 Water absorption with temperature change 20 °C / 40 °C
- Water absorption by diffusion at 50/1 °C according to DIN EN 12088
- Freeze-thaw resistance according to DIN EN 12091
- Water vapor transmission properties according to DIN EN ISO 12572, DIN EN 12086, DIN EN 13469
- Equilibrium moisture according to DIN EN 12429
- Moisture sorption according to DIN EN ISO 12571 (DIN 52620)
- Water absorption by partial immersion according to DIN EN 1609
- Moisture content according to DIN EN 322

Dimensional stability / shape retention

- Dimensional stability under constant normal laboratory conditions according to DIN EN 1603
- Dimensional stability under specified temperature and humidity conditions according to DIN EN 1604
- Deformation under speicified compressive load and temperature conditions according to DIN EN 1605

Other characteristics

- Volume percentage of open cells and of closed cells according to ISO 4590
- Cell gas composition with a gas chromatograph
- Chloride content of wood wool products according to DIN EN 13168
- Airflow resistance according to DIN EN 29053
- EN 29053

New measuring and testing equipment

Testing equipment for the determination of the tendency of a construction product towards continuous smoldering according to DIN EN 16733:2016-07
Stefan Sieber

Together with Germany, the European Commission has agreed that the protection of citizens with respect to the safety of buildings, health and environment is of utmost priority. Therefore, a regulation will be maintained in Germany according to which the previous fire protection level can be maintained and the hazards caused by glowing and smouldering of building parts can be taken into consideration even after the general approvals of the building supervisory authorities for harmonized building products have expired. The characteristic of continuous smouldering, which is missing on a European level, is currently being added in the respective harmonized product standards for some insulating materials. This affects:

- DIN EN 13162: Factory made mineral wool (MW) products
- DIN EN 14303: Factory made mineral wool (MW) products for building equipment and industrial installations
- DIN EN 14064-1: In-situ formed loose-fill mineral wool (MW) products
- DIN EN 13168: Factory made wood wool (WW) products
- DIN EN 13170: Factory made products of expanded cork (ICB)
- DIN EN 13171: Factory made wood fibre (WF) products

Thus, the assessment of the propensity of these insulating materials for continuous smouldering will be part of the CE marking. The verification according to the present standard drafts is to be provided by means of the corresponding type tests and within the in-house production control every two years.

The "Muster-Verwaltungsvorschrift Technische Baubestimmungen", which is currently introduced in Germany via the construction directives of the federal states, demands the following:

Image 1: Overall view of the testing equipment according to DIN EN 16733 at FIW München

Testing and inspection

"For constructions or construction components for which non-flammable or flame-resistant characteristics are required, it is to be ensured that a fire cannot spread due to an unnoticed progression of glowing and/or smouldering."

Since harmonized standards do not make any stipulations regarding the required product characteristics, it is important that the parties involved in the construction project are clear as to whether the construction products fulfil the requirements posed to them by the corresponding construction project.
The testing equipment described in the test standard DIN EN 16733:2016-07 is used for determining the propensity (capability) of a construction product to continuously smoulder if it is exposed to the impact of a natural convection air flow of an open flame.
Here, the surface of the vertically arranged test specimen is exposed to a constant flame of a propane torch over a period of 15 minutes (image 2).
Smouldering is verified by measuring the temperatures with thermocouples, which are installed in defined distances within the vertically arranged test specimen, and by the observation of the continuous flame formation due to re-ignition.

The test device was purchased, installed and commissioned in 2017. In the course of external training and numerous tests, the employees of the fire testing body at FIW München acquired the capabilities and experience for carrying out the test. With a testing body accredited as per DIN EN 16733, comparison tests were carried out and an excellent consistency in the temperature curves was noted. On 8 February 2018, the testing procedure was audited by DAkkS (Deutsche Akkreditierungsstelle) and the audit was passed with distinction.

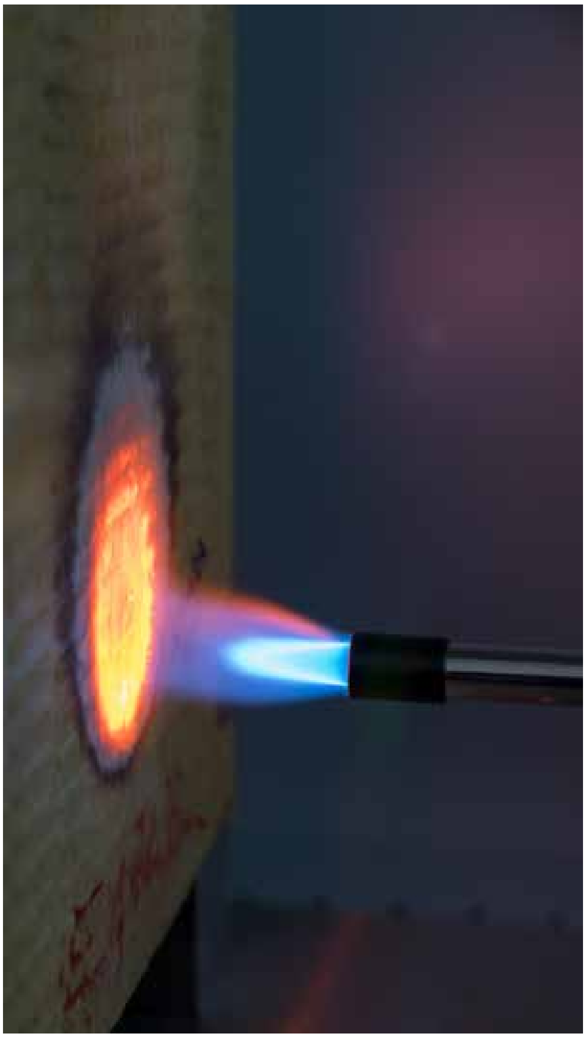


Image 2: Flame impact on the test specimen during the continuous smouldering test

Voluntary certification programs

After the Ü sign was abandoned in Germany in October 2016 for all insulating materials regulated by European standards, the certification body of FIW München underwent a successful development away from the certification body according to Landesbauordnung [regional building regulations] towards a certification body according to system 1 of the European Construction Products Regulation and voluntary certification programs. As the groundwork for these changes, voluntary certification programs have already been developed in cooperation with the industry and professional associations in the years before. In 2017, these voluntary certification systems had to prove their practicality and the acceptance among the insulating material manufacturers. Specifically, the following certification programs are offered and operated by the FIW at the moment.

Insulation KEYMARK (Keymark 2.0)

With the introduction of the Insulation KEYMARK, the basis has been created for a European certification system in which, in addition to two audits of the factory-internal production control, all declared characteristics and levels are verified annually by an independent and neutral body. In 2017, the KEYMARK certification was initiated for a whole range of manufacturers and the following insulating materials:

- Mineral wool insulating materials according to EN 13162
- EPS insulating materials according to EN 13163
- XPS insulating materials according to EN 13164
- Phenolic insulating materials according to EN 13166
- Wood wool insulating materials according to EN 13168
- Mineral wool insulating materials according to EN 14303
- Flexible elastomeric foam (FEF) according to EN 14304

All manufacturers and products with valid Keymark certificates have been published on the following website: Insulation-Keymark.org

Image 1: KEYMARK sign awarded by the FIW as a certification body

Certification program for polyurethane (PU) thermal insulating materials

In October 2016, the members of ÜGPU (Überwachungsgemeinschaft Polyurethan- Hartschaum e. V.) [quality assurance association for polyurethane hard foam] already decided on marking their certified products with the Q sign. The official starting date for the new certification program was July 1, 2017. After comprehensive preparation work and just in time for the start, 106 certificates and application attestations for manufacturers and dealers were published on the ÜGPU website. One special feature of the ÜGPU quality label is the fact that, in addition to the certificate confirming the compliance with all main characteristics, a “German application attestation” is also issued. With this application attestation, the user receives a verification that all minimum requirements of DIN 4108-10 are fulfilled and simultaneously that they can use the insulating material according to the application abbreviations as per DIN 4108-10.

Image 2: PU certification program

Certification program for EIFS insulating materials made of expanded polystyrene (EPS)

After the successful accreditation of the certification program for ETICS (external thermal insulation composite system) insulating materials made of expanded polystyrene, numerous certificates for ETICS insulating materials were already issued in 2017. They replace the previously voluntary monitoring of ETICS insulating materials which has already closed the gap between the external inspection of the insulating materials according to the German national approvals (abZ) Z-23.15-…. and the thermal insulation system according to ETA or German national approvals abZ Z-33-… Since the German approvals have been

omitted, these certificates are used as quality verification for the EPS insulation panels in the
ETICS and are used by customers, system manufacturers and certification bodies.
FIW München offers the following certification programs for EPS insulating materials for thermal insulation systems:

Certification program for ETICS insulating materials made of expanded polystyrene (EPS):

- Two audits per year, one of which without announcement; sampling and testing of nominal thickness twice per year

Expanded certification program for ETICS insulating materials made of expanded polystyrene (EPS):

- Two audits per year, one of which without announcement; with two complete tests and four tests of the thermal conductivity and tensile strength in total.

Forschungsinstitut für Wärmeschutz e.V. München

ZERTIFIKAT

„Z-Programm für WDVS-Dämmstoffe aus expandiertem Polystyrol (EPS)"

Produkt: "Fassadendämmplatte EPS 032 WDV kd IR"

Wärmedämmplatten aus expandiertem Polystyrol (EPS) nach DIN EN 13163

für die Anwendung in Wärmedämmverbundsystemen (WDVS) nach ETAG 004

Der Hersteller: xxx-Dämmstoffe GmbH, PLZ+Ort

hat mit dem: FIW München, Forschungsinstitut für Wärmeschutz e.V., 82166 Gräfelfing

für das Herstellwerk: PLZ+Ort

einen Vertrag über die freiwillige Zertifizierung des oben genannten Produktes geschlossen.

Produkteigenschaften vom FIW München zertifiziert:	Produkttyp: EPS 032 WDV kd IR	
Wärmeleitfähigkeit (EN 12667): Nennwert λ_D	0,032 W/(m K)	1x pro Produkt
Dicke (EN 823)	T(1) (± 1 mm)	1x pro Produkt
Zugfestigkeit senkrecht (EN 1607)	≥ 100 kPa	2x pro Produkt
Biegefestigkeit (EN 12089)	≥ 100 kPa	2x pro Produkt
Scherfestigkeit und Schermodul (EN 12090)	≥ 50 kPa ≥ 1.000 kPa	2x pro Produkt
Wasseraufnahme	≤ 0,2 kg/m²	1x pro Produkt
Wasserdampfdiffusionswiderstandszahl μ (EN 12086)	≤ 70	1x pro Produkt
Dimensionsstabilität	DS(N)2 DS(70,-)2	je 2x pro Produktgruppe
Länge und Breite (EN 822) Rechtwinkligkeit (EN 824) Ebenheit (EN 825) Rohdichte (EN 1602)	L(2), W(2) S(2) P(3) ≤ 25 kg/m³	je 2x pro Produktgruppe

Das Zertifikat ist gültig bis zum Datum. Leiter der Zertifizierungsstelle

Gräfelfing, Datum Dipl.-Ing. (FH) Wolfgang Albrecht

Image 3*: Sample certificate for ETICS insulation materials*

Certification program for mineral wool EIFS insulating materials

This certification program also closes the gap between the mineral wool insulating materials according to EN 13162 and/or ETAG 004 and the application for the ETICS in Germany for which the previous approval series Z-33.4-... will expire in the near future. This certificate also consists of two parts. Part 1 certifies the compliance with all relevant characteristics according to EN 13162 and ETAG 004. In part 2, the additional characteristics from the testing and inspection plans which are necessary for the application of the insulating materials in the framework of the system approval are certified.

Meanwhile, a whole series of certification agreements has been concluded for all voluntary certification systems and a large number of certificates have been issued. To professionally handle this large number of certification systems and certificates, the FIW works with a LIMS and contract management system, in which all data and registers for certification are stored centrally and which reminds employees automatically of audits and the extension of certificates.

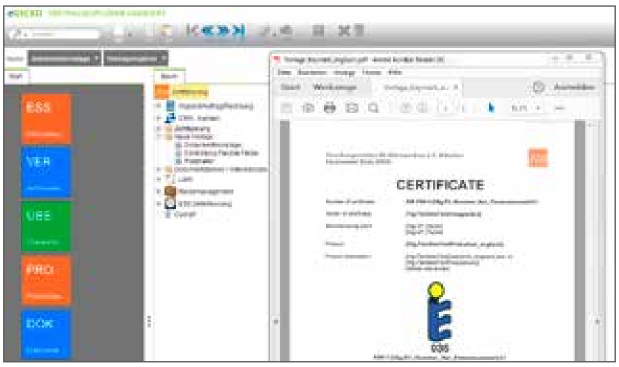


Image 4: Software for managing the certificates

4 Certifications

New ways for certification in Germany

After the decision of the European Court of Justice, it has become more and more obvious in the last few years that the external monitoring and certification practiced in Germany need a complete overhaul. In the future, there will only be audits and a certification according to AVCP system 1 (system for assessment and verification of the constancy of performance) for insulating materials, when intended by either the corresponding EN standard with respect to fire performance or an ETA (European Technical assessment). Some insulating material manufacturers even believed that they no longer need any regulations by the DIBt [German institute for construction technology] or certificates from independent bodies such as the FIW. However, this only applies to insulating materials which are regulated in an EN standard or ETA and for which AVCP system 3 is prescribed exclusively and for which a “product type determination” (TT or PTD, previously ITT) according to the corresponding standard or ETA is already given. Additionally, the application must be regulated in Germany, e.g. in DIN 4108-10. Non-standardized insulating material, e.g. fiber insulating material made of plant- or animal-based fibers or foam glass gravel, on the other hand, still need to be regulated in the form of national approvals to be able to use such insulating material in Germany.

Application attestation for Germany

As replacement for the “Ü-sign”, many manufacturers have chosen a voluntary certification of the characteristics declared in the CE-part of the label to maintain the trust of customers and users of their insulating material. For instance, this can be realized in the framework of the KEYMARK certification or in the certification program for thermal insulating material made of polyurethane (PU) which has been developed together with ÜGPU [Überwachungsgemeinschaft Polyurethan- Hartschaum e. V., monitoring association for polyurethane hard foam]. For the user, the question whether they can and are allowed to use the respective insulating material for a specific application in Germany is just as important as the compliance with a “quality promise”. Therefore, an application attestation for Germany is issued together with the certificate. This application attestation confirms that the product can be used for the applications as per DIN 4108-10 and that all characteristics needed for this purposes are regularly checked and certified. For this reason, the application attestation refers to the certificate which can be used in all European countries. Both the certificate as well as the application attestation may also be used separately, however.

Image 1: sample certificate and application attestation, PU

Design certifications for non-standardized applications

The case is different with European standardized insulating material without standardized application. In DIN 4108-10, for instance, the application of perimeter insulation with EPS is not regulated. The same applies to certain applications of XPS or foam glass in perimeter insulation in pressing water, in inverted roofs (e.g. green roof and parking deck) or under load-carrying foundation plates, which are not regulated under DIN 4108-2. In all of these cases, the DIBt has been issuing design certifications with a general validity of three years since November 2017. For an extension of these certifications, the manufacturer must prove to the DIBt that they still comply with the requirements mentioned in the design certifications. For this purpose, a so-called control plan of the DIBt exists, which is issued based on an EN standard or a possibly existing ETA. This control plan indicates whether regular audits according to AVCP system 1 are to be carried out by a notified body such as FIW München and which tests are to be carried out in the framework of factory production control and with which testing frequency. The tests can be carried out and evaluated by the manufacturer themselves; however, in such case, they must provide the testing equipment, verify the accuracy and plausibility of the measured values or, alternatively, commission an accredited and notified body such as the FIW München, for which the verification of objectivity, neutrality and the compliance with the measurement uncertainties, the participation in cooperative tests etc. is given any way. For this purpose, FIW München is developing a certification program for design certifications which are based on ETA. The certification program certifies that,

- 2 times a year, audits of the manufacturing factory and the factory production control
- tests according to the control plan are carried out by the testing body of FIW.

If all requirements of the certification program have been complied with, the manufacturer receives the following certificates:

- CE certificate according to system 1
- Quality certificate regarding the testing of all characteristics of the control plan
- Application certificate for the application in Germany

Such a voluntary certification program significantly simplifies the provision of proof to the DIBt and thus ensures that no tests are “forgotten” or not available in time. This leads to an improvement of the chances of a timely extension. The exact form of the regulations for insulating material for ETICS cannot be predicted with 100% certainty yet. However, if manufacturers want to launch new products which are not regulated in the Z-33.4-... approvals or if insulating material manufacturers wish to provide proof of a consistent quality towards system manufacturers, the FIW offers a certification program for ETICS made of EPS and mineral wool, which is introduced in the section “certification”. In summary, it can be said that in the future there will only be an external monitoring and certification for European standardized insulating material or insulating material according to ETA if the fire behavior is classified according to class C or better or if essential requirements with respect to mechanical characteristics exist. Additionally, there will also be voluntary certification programs which will be of utmost importance for the trust of customers and for the applicability of insulating material in Germany. However, these certificates will be used as evidence for the construction supervision and for the extension of design certifications.

5 Research and development

Overview

The research and development in thermal insulation department includes all the research activities of the institute. The main focus here lies on the thermal and hygric optimization of insulation and construction material as well as of components and insulated constructions. The developments made in this framework are increasingly accompanied by simulations. However, the quality of such calculations depends on the reliability and accuracy of the material property data sets with which the programs are fed. FIW München uses modern devices and testing machines to quickly and reliably determine material parameters and to ensure that nothing is left to chance. Here, FIW München is continuously increasing the range of offered measurements, for instance with respect to the determination of material parameters for the hygrothermal simulation of internal insulation systems, structural analysis of insulation and construction material and characterization of plasters and mortars. The simulations on components and parts can be verified by tests in the hot box apparatuses of the institute on entire components, such as facade elements, windows, gates, masonry and technical insulation systems, on a scale of 1:1.

A particular strength of the research and development department is the flexible combination of calculations, simulations, and laboratory tests. In particular, for new insulating material and construction products, e.g. vacuum insulation panels (VIP), insulating material based on aerogels and advanced porous materials (APM), thermal insulation plasters, moisture-adaptive vapor barriers, coated low-emission foil insulating materials or hollow bricks filled with insulating material, there are often no reliable material values as basis for numerical calculations available. FIW determines these material values as basis for calculation examinations of the product and accompanies manufacturers on their way to the market.

The expertise of the department with respect to thermal and humidity properties is also available to other sectors: Planners and manufacturers of chemical systems and power plant systems, manufacturers of refrigerators and freezers, air conditioning systems, transport containers and vehicles all use our expertise to optimize the thermal behavior and the long-term performance in the application. Here, a stationary observation of the heat transition is often not sufficient, in most cases, transient boundary conditions have to be applied, for instance the daily and annual curves of the temperature or the hourly climate data for a number of locations. Often, these temperature curves are also combined with realistic moisture/humidity conditions to analyse the moisture distribution in systems and exclude possible damage to the construction structures from the very beginning. The laboratory testing and simulations can then be carried out by means of on-site measurements, for instance in the framework of monitoring.

Improved energy efficiency in existing buildings and technical equipment are the key to a successful energy transition. Without a reduction in the thermal losses in existing buildings, the ambitious energy savings targets of the German federal government cannot be achieved – no matter how efficiently new buildings are designed.

The research and development department focuses on the entire value chain of the construction sector: from the material to the component and from the component to the complete thermally insulating building envelope. A comprehensive analysis considers the location of the building, the climate and even the user behaviour of the residents to obtain reliable statements on the permanent functionality of constructions and renovation measures.
In the financial year of 2017, ongoing research projects on the subject of improved energy efficiency with thermal insulation systems, which were commissioned by the Bundesministerium für Wirtschaft und Energie (BMWi) [German federal ministry for economics and energy] and funded by the project sponsor Jülich (PTJ), as well as the cooperation in the IEA Annex 65 „Long Term Performance of Superinsulating Materials SIM“, which was also financially supported by the PTJ, could be continued. The final

report for the IEA Annex 65 project has meanwhile been finished. For the research project on internal insulation, the final report is currently in progress and will be available in the summer of 2018.

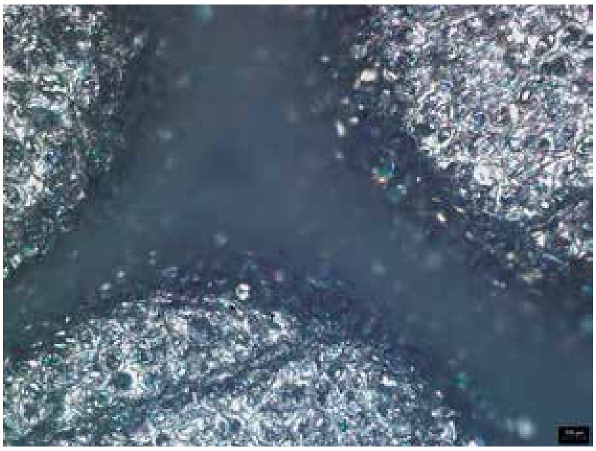
In 2017, new projects were acquired and started. In addition to some projects which were directly commissioned by companies, in particular, one project for the further development of wood fiber insulating materials, which was commissioned by Fachagentur Nachwachsende Rohstoffe (FNR) [central coordinating agency in the area of renewable resources] and which is managed by FIW München, as well as the participation in a project in the framework of the European EURAMET program for defining calibration standards and measurement regulations for determining the IR emissivity of component surfaces are to be mentioned. Another publicly funded project deals with the optimization of the thermal envelope of the buildings in Überlingen which were chosen for the research association “Stadtquartier 2050”. This project was commissioned by the BMWi in the framework of the energy research program.

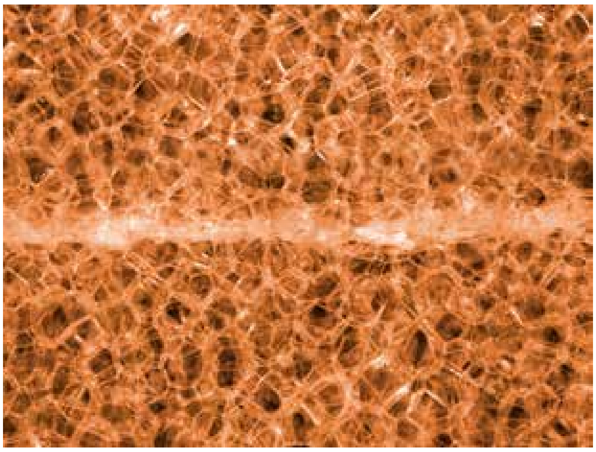
“INNOVIP”, the ongoing EU project on the further development of vacuum insulation panels with a total of 12 European partners, which is funded in the Horizon 2020 program of the European Commission, could be continued successfully. Here, FIW München is responsible for coordinating the project, which is funded with about EUR 5 million. Other projects are described in more detail in the section “Highlights from research and development”.

INNOVIP

Innovative multi-functional Vacuum-Insulation-Panels (VIPs)
for use in the building sector

Image 1: Logo of the EU project





Research and development opportunities in the area of thermal insulation

Research

- Carrying out research activities in all areas of thermal insulation and moisture/humidity protection of construction components, systems, and buildings
- Research on energy savings of buildings and energy efficiency
- Application-specific research into insulating material, construction material, and construction products
- Examination of fundamental issues regarding thermal and moisture/humidity, for instance systematic examination of production parameters for thermal characteristics or the impact of moisture/humidity on the thermal conductivity of construction and insulating materials
- Application for research projects and project management for research projects in Germany and Europe

Energy requirements of buildings

- Determination of energy requirements of systems or buildings
- Comprehensive examination of thermal losses, taking into consideration the location, the climate, and the user behaviour of the residents
- Potential estimations for renovations

Development of products and materials

- Optimization of thermal and moisture/humidity parameters of insulation and construction material as well as of components and insulation structures
- Accompanying further developments of materials, products, components, and construction parts by calculations and simulations using modern computer programs
- Measurement of the input data for thermal simulations
- Determination of thermal transmittance and moisture content of components and construction parts on a scale of 1:1 up to a component size of 3.5 x 3.5 m
- Combination of numerical calculations, simulations, and laboratory examinations for new construction products (e.g. vacuum insulation panels (VIP), moisture-adaptive vapor barriers, low-emission coated foil insulating material, or hollow bricks filled with insulating material) and scientific support until the market launch
- Calculations, simulations, and measurements of the thermal and moisture/humidity characteristics, including for non-construction sectors, e.g. refrigerators and freezers, transport containers, and refrigerated vehicles
- Support of the entire value chain in a construction project: from the material to the component and from the component to the complete thermally insulating building envelope

Other examinations and simulations

- Calculations in the transient state with increasing or falling temperatures
- Simulations of fluid dynamics (CFD)
- Measurements of components or materials with realistic moisture content to analyze the moisture distributions in systems and to better assess damage
- In-situ examinations and monitoring of existing and newly constructed buildings
- Examination and simulation of the ongoing functionality of constructions and renovation measures
- Studies and potential estimations
- Thermal bridge catalogues
- Support regarding technical manuals and product documentation

Technical insulation systems

The energy-related examination of technical insulation systems via detailed three-dimensional finite elements modeling and the possibility of calculating the thermal insulation of heated and refrigerated installations as per VDI 2055, part 1, “calculation rules”, leads to statements on and classification of the energy efficiency of operational systems in industry and the technical building equipment. Application-related tests of the insulation systems, which are carried out in parallel, provide verified parameters, which are of crucial importance in the assessment.
In the financial year of 2017 as well, FIW München was active in the area of knowledge transfer in thermal insulation and protection against cold. The basic documents in the area of “energy efficiency of operational systems” were developed in the VDI 4610 regulations committee. VDI 4610, Part 1, “Energy efficiency of industrial installations - Thermal insulation” with the definition of the energy efficiency classes for technical insulation systems was published in January 2018. Thereby, a classification of insulation systems and thermal bridges in technical installations is available for the first time for technical insulations. Thus, existing systems can be assessed, while new systems with a graduated energy efficiency requirement can be planned. Hence, the planned insulation measures become comparable and transparency is obtained with respect to the selection of the insulating material and the cost structure. With the introduction of the energy efficiency classes, insulation technology experts hope for innovations in technical insulation systems as well as adaptations of the specifications for the implemented insulations which put a clear emphasis on environmental aspects. VDI 4610, sheet 2, “Energy efficiency of operational installations – thermal bridges catalogue” for the calculation of specific thermal losses in installaion-related components is currently still in the survey phase.
The expert committee on the revision of VDI 2055 part 1, “ Thermal insulation of heated and refrigerated operational installations in the industry and the building services– Calculation rules” has consistently continued their work.

Image 2: Valve group as component of technical insulation systems

Highlights from research and development

In-situ measurement of the emission degree on a glass enclosure

Holger Simon

The Petuel tunnel in Munich was opened in 2002 as a road tunnel and is part of the “Mittlerer Ring” central ring road, which has a heavy traffic load. The traffic load amounts to more than 100,000 cars per day. The tunnel consists of two tubes and has a length of approximately 1,500 m. On the Eastern portal, a 240 m glass enclosure spans over the exit from the tunnel and the entry ramp at Leopoldstraße. The glazing is made of triple laminated glass, consisting of 2 annealed, 10 mm thick float panels and one 6 mm thick float panel made of single pane safety glass. To protect the supporting structure against improper heat impacts in the event of a fire, the panels are equipped with a coating system based on a transparent tin oxide layer on the inside, i.e. towards the internal area of the tunnel. By doing so, the emission degree of the panels is reduced significantly, i.e. to $\boldsymbol{\varepsilon} = 0.18$ in the new state.

Image 3: View into the locked glass enclosure during cleaning work

The high traffic load causes a contamination of the glass panels as road dust and soot from the exhaust gases of the vehicles accumulate on the panels. If this causes an increase in the emission level of the glazing, fire protection might no longer be guaranteed. For this reason, the panels are cleaned regularly, within intervals of approximately two years. To check and document the success of the cleaning measures, FIW München accompanies the cleaning with emission level measurements, which are carried out on the glazing on site.

European research project on the improvement of emission level measurements

Holger Simon

The EMIRIM project is a European research project on the improvement of the measurement of the hemispherical emissivity of reflective foils used in “reflecting insulation products”. The project was initiated upon request of the working group CEN / TC 89 / WG 12, which is responsible for stipulating test methods and declaring thermal characteristics for reflecting insulation products.

Currently, depending on the applied measuring techniques, the emission level measurement can produce great deviations between the measurement results. In a comparison of various measurement methods in 2013, for instance, values ranging from $\boldsymbol{\varepsilon} = 0.02$ to 0.08 were measured on the same reflecting foil. The causes for such discrepancies were not clarified. Plausible explanations were the geometrical, thermal and optical configurations of the instruments and the type of the reference sample used for the calibration (plane mirror or calibrated samples with diffuse reflection)

The research project thus had the following objectives:

- Improved knowledge regarding standard industrial procedures for measuring the emission level
- Improvement in the reference technology for measuring the emission level
- Production of calibrated reference specimens
- Improved calibration and measurement procedures for industrial applications
- Adaptation of the regulations for the emission level measurement on reflective foils

The project is funded by the European Metrology Programme for Innovation and Research (EMPIR) in the framework of the “Call 2016 - Normative”. The EMPIR program is presented under: https: https://www.euramet.org/research-innovation/research-empir.

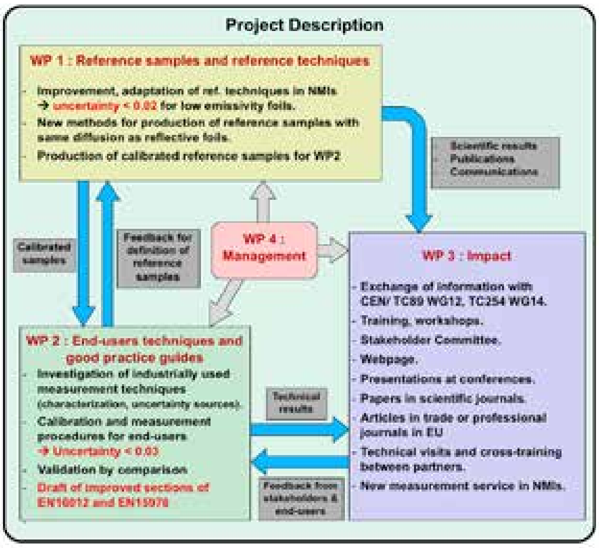


Image 4: Representation of the project structure with the individual work packages

Determination of sector figures - Economic significance of the building envelope in residential construction

Prof. Dr.-Ing. Andreas Holm, Christine Maderspacher

The Bundesverband energieeffiziente Gebäudehülle (BuVEG) [German federal association for energy-efficient building envelope] represents all trades involved in the building envelope. Its members are manufacturers of materials, components, and constructions parts used in the building envelope. As central contact, the association represents the interests of the entire sector in politics and towards the media.
As basis for argumentation and for the representation of the economic significance of the building envelope, the BuVEG requires reliable sector figures. FIW München was commissioned with providing an overview of the newly built and renovated building envelopes in Germany on an annual basis and with deriving the resulting turnover and employment effects created in this respect.
Based on data provided by Statistisches Bundesamt [German federal statistical office], an overview of the different new and existing building types and their living areas was prepared in the study. With this data basis, the annually, newly constructed and/or renovated building envelope in residential construction could be determined. Furthermore, cost estimations for the different construction parts of the building envelope, the roof, the external walls, the windows, and the base of the building were carried out. These were divided into material, device, and staff costs as well as into value-added tax according to their occurrence. With the determined staff costs, statements on the employment effects and their dependence on the new construction and renovation rates could be shown.

FIW durability study: FOAMGLAS®

Max Engelhardt

Since June 2016, FIW München has been undertaking a test campaign in order to evaluate the long-term performance of FOAMGLAS® thermal insulation products made of cellular glass in insulated flat roofs, on behalf of Pittsburgh Corning Europe (PCE). The study is intended to provide answers to various questions regarding the durability of cellular in building applications:

- What is the long-term performance of foam glass under real service conditions?
- How resistant is foam glass towards variations in the workmanship quality in the construction project and constructional defects?
- What are the long-term effects of environmental impacts on the material properties (e.g. freeze-thaw stress)?
- Can the durability of the products be connected to the core characteristics such as glass quality, chemical composition, gross density, or cell structure?

Generally, the study aims at obtaining new information regarding the actual long-term performance and durability of foam glass insulation products. Due to its restricted scope, however, the study cannot concludingly clarify all questions; rather than providing a general overview of the basics and the complexity of the issue.

5 Research and development

For this purpose, FOAMGLAS® samples were taken from buildings, which were selected by PCE. The samples were taken from 28 to 43-year-old buildings in different European countries, e.g. Belgium, Netherlands, United Kingdom and Sweden. An extension of the test series is planned for 2018.

- The sampling was carried out by taking foam glass samples from the roof constructions in accordance with an FIW regulation and, in most cases, under the supervision of qualified third parties (e.g. SECO). The regulation also includes specifications on the data collection on site and the transportation of the samples in vapor-proof, sealed packaging. The foam glass samples were characterized according to the applicable EN test methods in the FIW laboratories with respect to the following performance characteristics:

Image 5: Locations of the previously examined buildings (map of Central Europe)

Image 6: Examined buildings, sampling

- Thermal conductivity (EN 12667 in sampled condition and in dried condition)
- Compressive strength (EN 826)
- Moisture content (oven-dry method)

Factory made cellular glass products can be regarded as vapor tight and generally do not absorb any water, even when in contact with fluid water over longer periods of time. Water can adhere on the surfaces of the slabs (on the cells cut in production). According to the FOAMGLAS® processing regulations for roof constructions, the butt joints of insulation panels must always be fully glued with vapor-proof adhesive. If this regulation is not complied with, the trapped air in the butt joints can transport humidity, which condensates on the colder surfaces within the insulation layer. Defects in the roof insulation may also cause an increase of higher water quantities in the construction. Accumulated water can then be exposed to freeze-thaw cycles and, over time, damage the cell structure due to frost bursting, which leads to an advanced ingress of water into the insulating material in the long run.

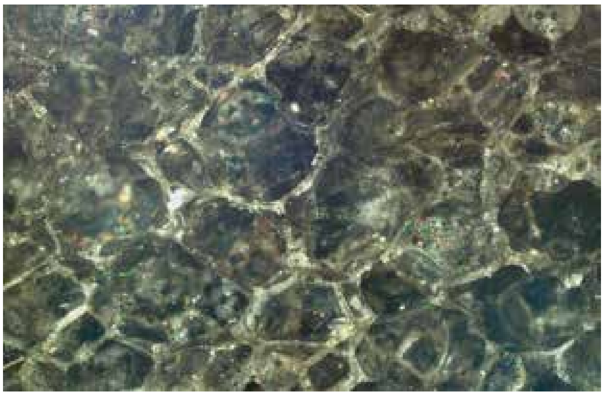


Image 7: *Foam glass with intact structure*

Image 8: Foam glass with superficial structure damage due to frost-thaw cycles

All test results were compared to the information in technical approvals which were available at the time of the erection of the building.

It was verified that, in all cases in which the water sealing of the component was still functioning at the point in time of the sampling and thus the moisture content of the construction was low, the FOAMGLAS® products built into a flat roof construction still demonstrated a high thermal insulation performance. In these cases, the results were close to the values indicated in the technical approvals, with a thermal conductivity between 0.043 W/(m·K) and 0.053 W/(m·K).

The results of the measurements in samples from damage-free constructions did not show any significant deviations between the thermal conductivity in the sampling condition and in the re-dried condition: The maximum difference was 0.001 W/(m·K).
All samples showed a high structural stability with a compressive strength of above 500 kPa and up to 1500 kPa. Thus, the measured compressive strength was greater than the values indicated in the historic approval documents in all cases. The expected interdependency between the compressive strength and the dry gross density was not noticeable in the samples.

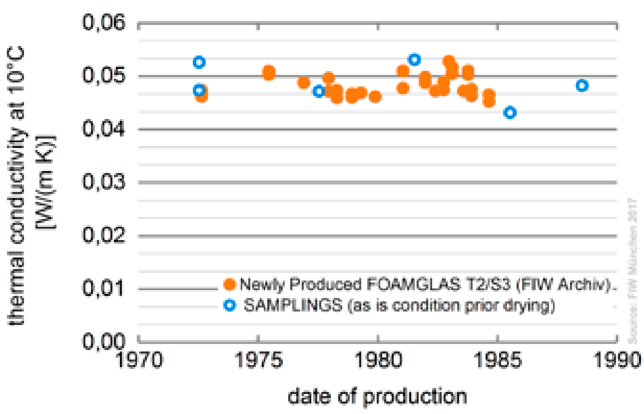


Image 9: Comparison of the thermal conductivity of the samples taken to date (without damage) with thermal conductivity after production (dataset, FIW archive, 1970 to 1990) – German only!

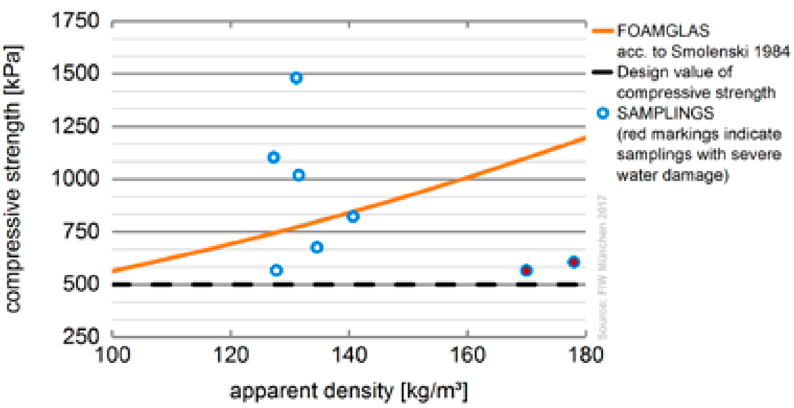


Image 10: Compressive strength of the samples taken to date – German only!

Generally, so far, no correlation between the duration of use of the tested insulating material and their characteristics could be identified.
Thus, when using FOAMGLAS® under suitable conditions, i.e. if there were no water build-up due to defective roof sealing or installations without butt joint adhesion, no aging effects in the sense of an increase in the thermal conductivity or of a reduction in compression strength could be detected.

Program on the scientific support of the product development and market launch of insulating materials based on aerogels and advanced porous materials (APM)

Dr.-Ing. Sebastian Treml, Susanne Regauer

Insulating materials based on aerogels and advanced porous materials (APM) have progressed from their laboratory development to their marketability in the last few years. These current innovations complement the established insulating materials range with efficient alternatives, in particular for highly energy efficient renovations and new buildings. First national approvals are granted by the supervisory building authority already for the first products for a number of applications in and on the building.
Aerogels, which were previously mainly silica-based, are already used as internal insulation for walls and/or as loose-fill insulating material in cavity walls. Similarly, numerous reference projects already exist for the application as ETICS. For internal insulation in particular, in addition to the long-term stability of the thermal conductivity, the moisture characteristics of the insulating material used are important.
The long-term performance with respect to thermal, hygric and mechanical characteristics with respect the often occurring combined load of temperature and moisture/humidity, which often occurs in building, is not yet known for this new material class. Hence, it is important to build up trust in these materials among the processors and planners and to be able to make reliable statements regarding the long-term performance in building applications. To calculate the service life in specific building applications, therefore, knowledge regarding the aging performance of aerogels and APM is necessary. For this purpose, the responsible physical and chemical mechanisms are to be examined in order to make reliable statements on the long-term stability. On the one hand, this refers to the design value of thermal conductivity which applies to the long-term state of use in the building. On the other hand, it also and particularly applies to the hygric and mechanical characteristics of the insulation products made of aerogels and APM, such as granules, fleece mats, pasty masses and insulation slabs.
In the framework of this project, therefore, aging tests are carried out with combined moisture and temperature tests. The framework conditions in this respect are determined based on hygrothermal component simulations. Additionally, the measuring procedures for the thermal, hygric, and mechanical substance characteristics must also be adapted to the specific characteristics of these highly thermally insulating materials. For some physical characteristics, proven measurement and simulation methods, which have been broadly utilized for conventional insulating materials for years, can be applied here. For some other characteristics, existing and standardized measuring methods with additional conditions and adaptations for the highly insulating products can be used analogously. In many cases, however, these conditions are not known or insufficiently known. The insulating material is examined before, during, and after artificial aging. The mechanical characteristics such as compression and tensile strength or dimensional stability, for instance, are assessed after four aging steps of 90 days each.
Aerogel granules are also used in translucent insulation systems. Structural modifications in the material can be the result of the impact of UV radiation. By means of special weathering devices, the UV radiation resistance of the materials is also assessed.
Additionally, the recyclability of the various materials is also assessed. The selection and testing of suitable recycling processes is of particular importance with respect to composite materials. A reuse or recycling with recovery of raw materials in the end of the life cycle is also interesting from an economic point of view with cost-intensive raw materials like aerogels. Approaches to functional disintegration and separation procedures are researched and tested on the laboratory scale.

Validation of the foil lifting procedure for determining the internal pressure of VIPs with a core material made of pyrogenic silica

Susanne Regauer, Dr.-Ing. Sebastian Treml

The internal pressure of vacuum insulation panels (VIP) is decisive for the low thermal conductivity of these insulation materials and thus an important parameter for the assessment of the quality of panels. For the measurement of the internal pressure of the vacuum insulation panels, the most frequently applied method is the foil lift-off procedure. Here, the VIP is positioned in a vacuum chamber and the pressure in the chamber is continuously lowered by means of vacuum pumps. During the evacuation process, the internal chamber pressure and the movement of the surface of the VIP envelope are recorded. When the internal chamber pressure falls below the internal pressure of the VIP, the foil is lifted off the core; this process is recorded by the laser distance sensors. By means of suitable evaluation procedures, the internal pressure of the VIP can be calculated based on the functional correlation between the translation of the monitored point of the envelope and the barometric pressure in the chamber.

This indirect measuring procedure is currently still without verification or comparative measurements with a direct method. In order to check the correspondence of the measurements of the lifting processes of the foil from the core to the actual internal pressure and to define the boundary conditions for the measurements, this project was carried out at FIW for the Vacuum Insulation Panel Association (VIPA International).

Initially, the boundary conditions for the measurement of the internal pressure with the foil lifting procedure were defined. For this purpose, numerous factors impacting the measurement results were examined in comprehensive measurements series, such as the impact of the support of the VIP in the chamber, the number and positioning of the laser distance sensors for monitoring the movements of the foil, and the control of the internal chamber pressure with respect to the pressure drop rate and the intermediate ventilation. These parameters influence the result and can make the evaluation of the recorded raw data more difficult.

With this modified measurement assembly, measurements for the validation of the foil lift-off procedure were implemented. Custom-built test specimens with adapters for penetrating the panel cover enable the simultaneous measurement of the internal panel pressure, the foil movement, and the corresponding pressure in the vacuum chamber. Based on this, the relationship between the three measured parameters can be derived. The specimens consisting of a stand for fixing the adapter within one half of the foil envelope and a conventional VIP core made of silica in the second half are initially evacuated via the adapter (see figure). Subsequently, the entire unit is then placed in the vacuum chamber and the foil movement of the flat half is monitored, while the internal pressure of the panel is continuously recorded via the adapter. When the pressure in the chamber falls, a significant drop in the internal panel pressure occurs.

This project was completed with the conclusion that the foil lifting procedure is an adequate method for determining the internal pressure. A period of at least 24 hours between the production and/or the evacuation process and the internal pressure measurement is necessary to complete the pressure equalisation in the nanoporous core material.

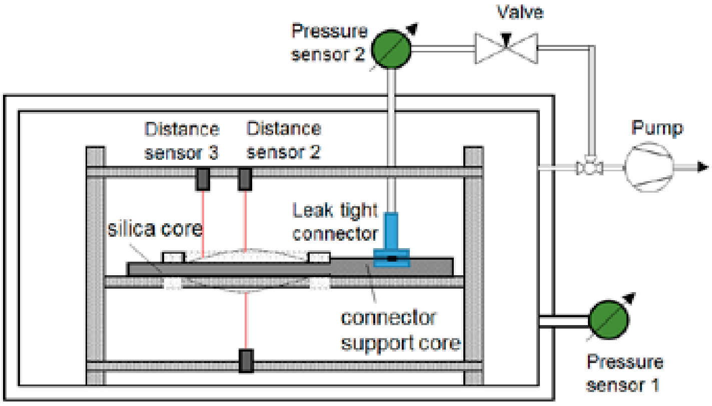


Image. 11: Measurement setup to determine the VIP internal pressure

Innovative, multifunctional vacuum insulation for the application in the building sector (INNOVIP)

Susanne Regauer, Christoph Sprengard

Since fall 2016, the FIW participates in the INNOVIP ("Innovative multi-functional vacuum insulation panels (VIP) for use in the building sector" – grant agreement no. 723441) project, which is funded by the European Commission via the framework program for research and innovation Horizon 2020.

The FIW assumes the role of the coordinator of this project and works together with twelve other partners from seven European countries and Israel in the development of new VIPs. The project period is 36 months; in September 2019, the results will be presented in Brussels.

The INNOVIP consortium aims at a substantial improvement of the vacuum insulation panels previously available on the market. Through innovative technologies, the development of new materials, and an improved production process, existing problems with VIPs are to be solved. Here, special emphasis is placed on the efficiency, price and service life. The new VIP can be flexibly used both for internal as well as external applications. In the long run, they are intended to contribute significantly to the reduction of the carbon footprint of buildings.

In 2017, a special emphasis was placed on the formulation of the ideal composition of the core material and the improvement of the envelope foil characteristics. In addition to these basic components, the selection and the planning preparation of demonstration objects was part of the project work. Buildings close to the project partners in Portugal and Poland were nominated for different applications. A comprehensive monitoring concept for assessing the actual performance of the panels shall also evaluate the state before renovation and therefore needs sufficient lead time. In parallel to the technical areas of activities, the preparation of marketing activities and the creation of communication material, for instance the twitter account with further information on current activities (@INNOVIP_H2020) were implemented.

Geea – Building studies: Scenarios for a market-economic climate and resource protection policy in the building sector for 2050

Andreas Holm, Florian Kagerer

The climate policy targets of the German federal government prescribe a reduction in greenhouse gas emissions of 80 to 95 % for Germany until 2050. Due to the significant share in the overall energy consumption, the building sector offers great potential for savings in energy and thus in greenhouse gas emissions. Due to the growing share of electricity-based supply systems and storage, at the same time, the interaction of energy systems and buildings becomes increasingly important. Thus, the building sector assumes a decisive role in the transformation of the energy system.

By request of the members of the alliance for building-energy efficiency (geea) and in the context of the dena "integrated energy revolution" study, Deutsche Energie Agentur (dena) [German energy agency] was commissioned with describing different development scenarios for the climate-political targets and examining their economic effects on the building sector. Together with the ewi Energy Research & Scenarios gGmbH and the Institut für Technische Gebäudeausrüstung Dresden (ITG Dresden) [Dresden institute for technical building equipment], they had the task of developing a calculation model based on which the interaction of energy system, supply technology, and building can be examined with respect to the economic as well as energy- and climate-relevant criteria. In the building module developed by the FIW, the existing residential and non-residential buildings, the construction age categories and the respective energy standard are included. Taking into consideration the developed lead scenarios and future energy standards, the building module enables a mapping of the energy requirements and the CO2 emissions for existing buildings in Germany until 2050. Based on the results, the necessary actions with respect to the future building standards for new buildings as well as for the renovation rates for the existing buildings can be derived and compared. Additionally, the retroactive effects from the transformation paths of the building sector can be mapped to the integrated energy system.

The calculations show that the climate protection targets

	Szenario	RF	EL80	EL95	TM80	TM95
Vollsanierungsäquivalente in Wohngebäuden [%]		0,8 - 1,1	1,6 - 2,8	1,8 - 2,8	1,4	1,4
Endenergiebedarf im Gebäudesektor nach EnEV in 2050 [TWh]	Gas (inkl. synthetischer Anteile)	258,7	23,5	17,9	151,0	140,9
	Öl (inkl. synthetischer Anteile)	54,2	3,5	1,8	43,9	40,9
	Biomasse	63,2	24,9	22,2	50,4	50,6
	Strom	74,7	144,3	138,8	97,7	103,6
	Fernwärme	64,3	45,5	39,9	52,7	51,3
	Summe	515,1	241,7	220,6	395,7	387,3
PtX-Bedarf Gebäude in 2050 [TWh]		-	-	7,0	43,0	142
Mehrkosten Gebäudesektor ggü. Referenz [%]		-	+20	+21	+12	+14

Image 12: Central study results for the building sector (according to EnEV) according to scenario. Source: Building study "Scenarios for a market-based climate and resource protection policy 2050 in the building sector"; Deutsche Energie-Agentur GmbH (dena). 10/2017

of the German federal government cannot be complied with if the current trend (reference scenario) with respect to the energy efficiency and the development of renewable energy is continued in the future.
Based on the two alternative trend scenarios of “technology mix” and/or “electrification” of the supply technology, the CO2 reduction targets between 80 and 95% are achievable. While the technology mix is based on a number of possible supply systems which are partially combined with synthetic fuels, the electrification foresees a massive development of heat pumps, which are mainly supplied by electricity from green sources. Here, the technology mix represents the economically more favourable option for achieving the goals since the existing infrastructures in the energy system can be used better. All results are based on the fact that the renovation rates for the existing buildings would need to be significantly increased from their current levels of between 0.8 to 1.1% for each scenario to 1.4 up to 2.8% as full renovation equivalent. Thus, the study provides important action recommendations for designing future framework conditions.

Long-term performance of moist insulating material on flat roofs

Dr.-Ing. Sebastian Treml, Ramona Holland, Chiara Cucchi

DThe research project was conducted in a cooperation of Aachener Institut für Bauschadensforschung und angewandte Bauphysik gGmbH [Aachen institute for constructional damage research and applied construction physics] and Forschungsinstitut für Wärmeschutz e.V. München. The final report summarizes the current experience from the experts’ practice in handling dampened insulation layers (AiBau). Additionally, laboratory measurements for determining the thermal conductivity of insulating material depending on the moisture content are presented with the aim of verifying the moisture mark-up factors stipulated in DIN EN ISO 10456 for the most important insulating material groups EPS, XPS, PUR and mineral wool (FIW).

The authors conclude that the damp insulation layers can be retained in many cases provided that the moisture content does not have any long-term effects on the adjacent moisture-sensitive construction materials (e.g. wood, corrosive fixing material, etc.). In the report, suitable boundary conditions and practical recommendations for modernization measures are described and legal aspects with regard to retaining moist insulation layers in the different phases during the construction implementation and/or in the event of damage are discussed. (AiBau)

The laboratory measurements carried out at the FIW confirm that, for the examined foam plastics of the current generation, the progressive correlation of the thermal conductivity as function of the moisture content as per DIN EN ISO 10456 represents the real performance in a qualitatively good manner. The moisture conversion factors indicated in the standard are also still up-to-date when compared to the laboratory measurement results. In contrast, the thermal conductivity of mineral wool with a greater gross density showed a thermal conductivity as a degressive function of moisture content. Under the laboratory measurement conditions, higher values of the thermal conductivity were also determined compared to the calculative determination by applying the moisture conversion factors as per DIN EN ISO 10456.

The determination of the thermal conductivity of moist material is impacted by moisture redistribution during the measurements within the sample cross-section; therefore, the selection of suitable equilibrium criteria in the observation of heat flux is of particular importance for the termination of the measurement. In the research project, the thermal conductivity was determined under stationary and transient temperature conditions. Here, it can be shown that under temperature fluctuations which are representative for one day/night cycle when evaluating the thermal flows on the warm side, thermal conductivity values which deviate from the stationary case were determined. The applied procedure under transient temperature conditions could be beneficial for determining the thermal conductivity of moist substances since, through the cyclically reversing heat flows, the moisture moves between the warm and the cold side. When evaluating the average heat flows, this could lead to latent heat effects and the increased heat flows from energy transported by vapour diffusion balancing each other out over the course of a temperature cycle.The research project was funded by Forschungsinitiative Zukunft Bau [research initiative for the future of construction] of Bundesinstitutes für Bau-, Stadt- und Raumforschung [German federal institute for research on building, urban affairs, and spatial development].

Long-term performance of super-insulating materials in building components and systems
Subtask 2 Characterization of materials and components – Laboratory scale

Dr.-Ing. Sebastian Treml, Chiara Cucchi, Christoph Sprengard

The research project with the short name Annex 65 is part of a series of projects in the program "Energy in Buildings and Communities (EBC)" of the "International Energy Agency (IEA)". The project documentation will likely be published in June 2018 and consists of a total of four subprojects, which deal with the long-term performance of super-insulating materials (SIM) in building applications. The term SIM comprises insulating materials with a very low thermal conductivity compared to conventional insulating materials. Even though the definition of the term is not yet concluded, in general, this term includes advanced porous materials (APM, e.g. aerogels) and vacuum insulation panels.

Subproject 1 summarizes the state of knowledge with respect to the manufacturing procedures and characteristics of SIM. In subproject 2, a cooperative test for determining the thermal characteristics of SIM before and after artificial aging was initiated under the direction of the FIW. Altogether, 20 laboratories from an international environment participated in the cooperative test. Two APM and five VIP were stored under different climatic conditions, while the thermal conductivity, the thermal bridge effect at the butt joint of two panels, and the internal pressure of the VIP were measured. The determined values and the measurement and handling procedures applied in the laboratories were documented and evaluated.
When determining very small thermal flows like the ones that occur under common temperature differences in the plate device for determining the thermal conductivity of SIM, the question of measurement uncertainties plays an important role. For this reason, the report thoroughly discusses the determination of measurement uncertainties depending on the equipment used and identifies the criti-

cal impact parameters by means of a sensitivity analysis. From the findings gained, recommendations on the measurement of the thermal conductivity of SIM could be derived. For instance, the determination of the thickness and the application of a sufficiently high temperature difference play an important role when it comes to keeping the measurement uncertainties as low as possible.

Additionally, the report contains current research results regarding the modelling of the permeation of dry air gases and water vapour through high barrier foils of VIP. Here, theoretical approaches are followed and practical measurements for modelling are used. Based on the interdependencies between the climatic conditions and the internal pressure, the thermal conductivity is calculated as function of the duration of use for a series of exemplary constructions. From these time courses, the mean thermal conductivity during the first 25 years of usage can subsequently be shown. Image 1 depicts isolines of mean thermal conductivity of an exemplary VIP in the axis of coordinates between effective temperature and effective relative humidity during the first 25 years of use as well as the realizations for the application in different constructions (K1 = flat roof, K2 = pitched roof, K3 = ETICS, K6= ventilated facade) and in different climate classes according to Köppen-Geiger (Aw = moist/hot, Bwh = dry/hot, Cfa = moist/warm, Cfb = moist/moderate, Dfb = moist cold).

Subproject 3 deals with the practical application of SIM for the energy-related renovation of the building envelope. Thanks to the very slim shape of SIM, benefits arise in particular in combination with restricted spatial conditions. The material-specific particularities with respect to thermal bridges, restricted cutting options, and sensitive handling, however, require particular attention in planning and in practice. Finally, subproject 4 deals with the question of sustainability of SIM.

The research project was funded by the International Energy Agency (IEA) in the Energy in Buildings and Communities (EBC), Annex 65 program.

Micro structure modeling for optimizing wood fiber based thermal insulating materials

Sebastian Treml, Max Engelhardt, Christoph Sprengard

The research project with the acronym Low Lambda is realized in cooperation between the Institut für Techno- und Wirtschaftsmathematik (ITWM) [institute for industrial mathematics ITWM] in Kaiserslautern, an industrial partner, and FIW München. The project aims at a thorough examination of the dependence of the thermal conductivity of wood-fiber based insulating materials and the microstructure of the material. Algorithms, which are to be developed and which will also consider radiation and convection in addition to the thermal conduction through the solids parts, are applied to a detailed morphological model based on µCT data (ITWM) for modelling the heat transfer. The models are validated via comprehensive measurements on a broad variation of materials (FIW). With virtual material design methods, potentials for minimizing the thermal conductivity are identified. Through precise documentation of the production parameters when producing the samples, correlations between fibre and material structure and the production conditions are searched for during the runtime of the project; these findings enable the production of specifically adapted fibre and material structures. Through the interdisciplinary cooperation of the partners in the collaboration, a comprehensive clarification of the dependencies between the production parameters, the fibre morphology, the structural characteristics of the material, and the resulting thermal conductivity is expected.

Image 14 shows an example of a virtually created cellulose fibre network with the same gross density but with a different orientation of the fibres towards the z axis. The images on the right-hand side of the figure show more fibres oriented to the z axis. The thermal flows in the z axis which are thus increased can be clearly identified. The effective thermal conductivity is thus increased compared to the fibre structure on the left-hand side of the figure.

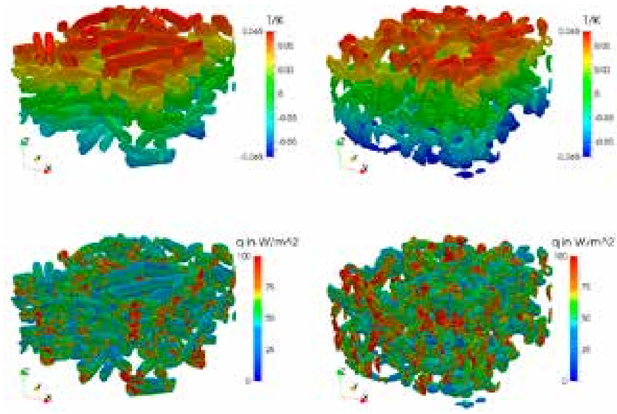


Image 13: Simulation of thermal conduction in two different cellulose fibre networks with the same bulk density but with different fibre orientation. Left top/bottom: Isotropic fibres oriented at x-y level; right top/bottom: Isotropic fibres oriented at x-Y level but more fibres oriented at z axis (source: ITWM 2017)

In addition to the project coordination, the activities in subproject 1 (FIW) include the physical characterization of the raw materials with respect to the grain size distribution, the thermal, the flow-dynamic, and the mechanical characteristics. Additionally, examinations on the thermal performance under transient temperature conditions at usual moisture contents levels are implemented. The examinations are used for the initial characterization, model validation and the verification of the results of the optimized test materials. Moreover, the models for the calculated examination of the thermal conductivity are developed further in cooperation with subproject 2 (ITWM), taking into consideration glued areas and thermal radiation.

The research project is funded by the Bundesministeriums für Ernährung und Landwirtschaft [German federal ministry of food and agriculture] based on a resolution by the Deutscher Bundestag [German federal parliament].

Expansion of the laboratory equipment - structural analysis

Dr.-Ing. Sebastian Treml, Holger Simon, Max Engelhardt, Christoph Sprengard

The structure of insulating materials and the interaction of the material with the ambient moisture/humidity have an extensive impact on the characteristics and the usability under specific climatic conditions.
For the structural analysis, a digital microscope of the type DVM6 by Leica was acquired. Two lenses with an enlargement of up to the 4740-fold and a resolution of less than 0.5 µm are available. Compared to an analogue light microscope, the high-performance digital image processing offers numerous options for further evaluation. One interesting option, for instance, is taking images with an extended depth of field and presenting them three-dimensionally. On the one hand, heavily structured surfaces and fibre networks can be recorded intuitively this way; on the other hand, surface roughness and clearances can be accurately measured. Possible applications for 2-dimensional image evaluation are the fibre thickness analysis and determination of cell sizes.

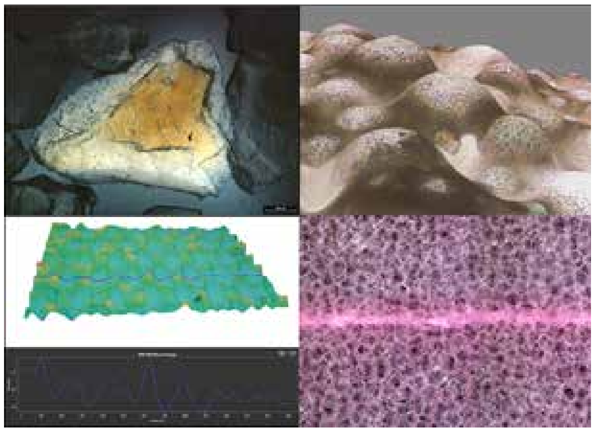


Image 14: top left: Aerogel particles, top right: Image with extended depth of field of micro hollow spheres in suspension with the lens in tilted position, bottom left: 3D-measurement of a structured surface; bottom right: View on the thermal bonding layer of multi-layered, welded XPS

For the determination of the volume of solid substance, a "Pycnomatic HTC" helium pycnometer by POROTEC GmbH was acquired. This is a fully automatic measuring device for determining the solid volumes of powders, granules, porous solids, and the volume of fluids. The solid volumes are determined based on the measured pressure changes via the isothermal gas expansion of a constant measuring gas volume in the gas pycnometer, with two calibrated partial volumes, which are connected to each other via an isolation valve. Helium is used as measuring gas as it has a very small atom diameter and thus also enters very narrow pores in the solid material and allows for the determination of the actual solid sample volume.
The mass of the solid material is determined by weighing with a highly accurate scale (not included in the device). The density of the solid material is calculated from the ratio of the mass of the solid material and its volume. The porosity of the solid is determined based on the solid's volume and the geometric volume.

Image 15: Pycnomatic HTC He-pycnometer for determining the solid's volume

Depending on the raw material and additives (binding agent, flame retardant, etc.) used, insulating materials are more or less hygroscopic. For hygrothermal modelling in particular, the most accurate knowledge regarding the sorption performance, including under different temperatures, is important. For the scientifically accurate determination of sorption isotherms within a range of 0 – 98% relative humidity and temperatures between 5°C and 60°C, a sorption measurement systems of the type SPS-1µ High Load by proUmid was acquired. The multi sample devices can be equipped with different sample holders depending on the sample size. This means that 5 to 23 samples can be examined in parallel under identical conditions. In particular for the examination of the differently treated specimens (hydrophobing agents, flame retardants, colour variations, differences in the gross density, etc.), this concept offers the benefit that measurement deviations due to fluctuating climatic conditions or deviating weighing intervals can be excluded. Thanks to the precise moisture and temperature regulation, hysteresis effects can be shown with a high resolution.

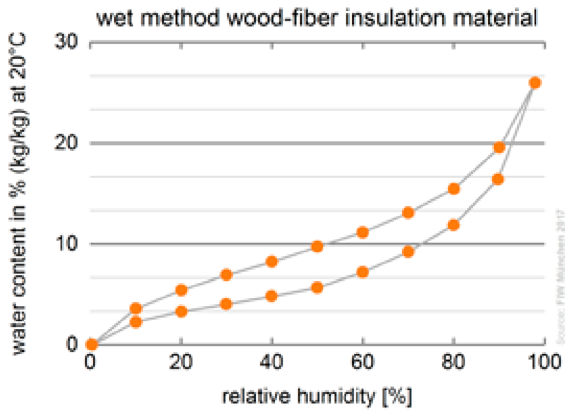


Image 16: exemplary measurement results of the equilibrium states between 0% and 98% of relative humidity at 20°C of a single sample, measured with the proUmid sorption measurement system – German only!

FIW test body with internal calibration laboratory

Image 2: Rotronic monitoring system

The fact that an accreditation by DAkkS (Deutsche Akkreditierungsstelle [German accreditation authority] in Berlin) has only a little to do with the Latin root word meaning "believe" but is more of a systematic and comprehensive evaluation of a quality management system by experts and system assessors is not questioned. The basis for the accreditation of FIW München is provided by a quality management system which, at the same time, fulfills the requirements towards a certification body according to DIN EN ISO /IEC 17065 and a testing body according to DIN EN ISO/IEC 17025.

The use of calibrated testing equipment, which is traced back to international and national norms, as well as the further development and optimization of testing devices have been the norm for decades.
The process of continuous improvement can only be realized with colleagues who dedicate their hearts and their minds to their work.

In this context, FIW München has installed a new system for climate monitoring.

This modular system consists of hardware elements and server-based software and monitors the climate in laboratory rooms, climatic chambers, climatic cabinets, and drying cabinets. The data loggers record all measuring data of the calibrated sensors and transfer them to the database. Here, the measuring data is stored and provided to all users. In addition to the user-friendly visualization of measuring data, alarm messages are sent via email if the prescribed temperature and/or humidity limit values are exceeded. By means of the report function of the validated software, the verification that the prescribed climate conditions were complied with during testing is rendered with little effort.

eGecko – gained flexibility is paying off

The introduction of the eGecko ERP and LIMS software has accompanied the FIW for a while now. The FIW is subject to external changes and must also react with an adaptation of internal process; for instance, the main software must permanently follow the internal processes. Thus, the legitimate question arises whether pivotal software like that can ever reach the "finished" status.
In addition to the forced adaptation – as in 2016 – all areas were driven further forward. Processes were refined, new functions were added, ideas were born and implemented. The results are smooth work processes and tightened procedures.

Some examples are:

- Simple creation of comprehensive overviews from contract management and product database
- Creation of PDF offers
- order confirmations and invoices with high parameterization
- automatic forwarding to the assigned personnel

By now, most measuring stations have been connected to the LIMS software; in many cases this was used for a modernization of the measuring station itself. This way, often, the outdated hardware was replaced with modern computers with the latest operating systems. With the software itself, however, significant improvements could also be achieved. Measuring protocols are now stored in the measuring station via PDF and provided via an import in LIMS. Laboratory technicians receive the measuring protocols via email and laboratory technicians and the device engineers are informed about errors and/or suspicious deviations via email and without additional actions.

Another benefit of the highly configurable software which can now be enjoyed thanks to the diligent and forward-looking planning of the project team is the gained flexibility. It enabled an integration of the testing facility for determining the inclination of a construction product for continuous smouldering according to DIN EN 16733:2016-07 with minimum time effort into the LIMS system.

Four steps to the new LIMS test

Step 1:

From a LIMS-related point of view, a new test is a parameter scope which consists of several parameters (one parameter corresponds to the measured value, e.g. length, which is determined by the measuring station).

Step 2:

Flexible data export which is configurable exclusively via LIMS and is configured "on the side" when creating the parameter scopes for new tests.

Step 3:

Flexible import/export module at the measuring station based on Excel and .NET.
The import enables a quick and clear representation of master data as well as a clear input - also automatized input - of measured values.
The export part writes measurement data files, creates measurement protocols (print/PDF) and manages the handover of these PDF protocols as well as additional graphs and images to the document import interface of eGecko.

Step 4:

Allocation of measuring data and measuring protocols to the corresponding LIMS job with the option of applying any, including complex, scripts to the imported measuring data.
Admittedly the four steps are the core of the integration. What is necessary is, among others, an article. Of course, a test report for the customer is also a must. Here, the new software is of help, too. The graphic report designer is the means of choice here. It guarantees quick success – even if the single-sidedness of the reports have caused severe desperation among our team a few times – and had to be softened, for instance for the "smoldering report" due to the diagrams and images.
For 2018, the eGecko team sees sufficient potential for optimization and is looking forward to put this into practice.

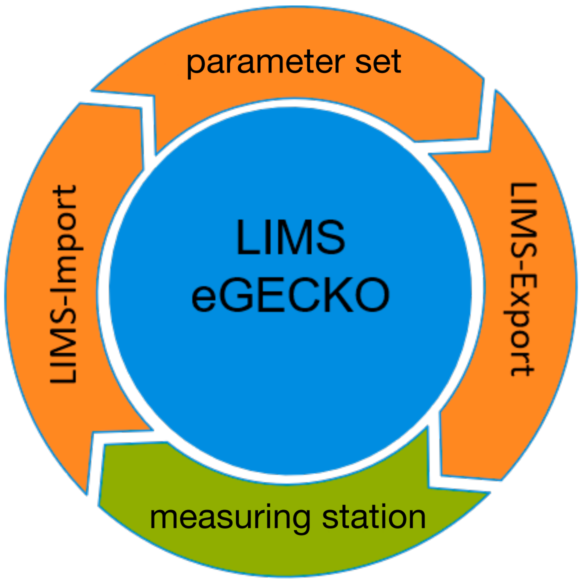


Image 3: Four steps to the new LIMS testing.


L1~
A1+
PHOENIX CONTACT
ON
5
AC51 : 30A, 600V~
AC53a: 15A, 600V~
Vcc: 4-32V
ELR 1-24DC/600AC-30
Ord.Nr.: 2297154
T1~
A2-
L1~
A1+
PHOENIX CONTACT
ON
6
AC51 : 30A, 600V~
AC53a: 15A, 600V~
Vcc: 4-32V
ELR 1-24DC/600AC-30
Ord.Nr.: 2297154
T1~
A2-
L1~
A1~
PHOENIX CONTACT
ON
7
AC51 : 30A, 600V~
Ac53a: 15A, 600V~
Vcc: 24-275V~
ELR 1-230AC/600AC-30
Ord.Nr.: 2297167
T1~
A2~

National committees and boards

AGI (Arbeitsgemeinschaft Industriebau) [working group for industrial construction]

- AGI Arbeitsblätter der Reihe Q [worksheets of the Q series]
  Ralph Alberti
- Erfahrungsaustausch PÜZ-Stellen, Schaumkunststoffe und Holzwolle [experience exchange of testing, inspection and certification bodies, foam plastics and wood wool]
  Wolfgang Albrecht

GSH (Güteschutzgemeinschaft Hartschaum e. V.) [quality control association for hard foam]

- PUR-Ortschaum (Gießschaum) (RAL-RG 710/7) [PUR in-situ foam (molding foam)]
  Ralph Alberti
- GFA-PUR – Gemeinsamer Fachausschuss PUR - Dachspritzschaum und PUR - Spritzschaum [joint experts' committee PUR roof spraying foam and PUR spraying foam]
  Stefan Kutschera
- Arbeitsausschuss Polystyrol (AAPS) [polystyrene working committee]
  Stefan Sieber
- Güteausschuss [quality control committee]
  Stefan Sieber
- Lenkungsgremium [steering committee]
  Stefan Sieber

DIBt (Deutsches Institut für Bautechnik) [German institute for construction technology]

- SVA-A Baustoffe für den Wärme- und Schallschutz [construction material for thermal and noise insulation]
  Wolfgang Albrecht
- SVA-B1 Wärmeleitfähigkeit [thermal conductivity]
  Wolfgang Albrecht
- SVA-B3 Außenliegende Wärmedämmung [external thermal insulation]
  Wolfgang Albrecht
- SVA Dauerhaftigkeit von feuchtevariablen Dampfbremsen [durability of moisture-variable vapor checks]
  Sebastian Treml
- Ad-hoc committee: Lastabtragende Wärmedämmung größerer Dicke unter der Gründungsplatte [load-bearing thermal insulation of greater thicknesses below the foundation slab]
  Wolfgang Albrecht
- ABM-Kolloquium der Brandschutzlaboratorien [ABM colloquium of the fire protection laboratories]
  Wolfgang Albrecht

Hauptverband deutsche Bauindustrie (HDB) – Bundesfachabteilung WKSB [main association of the German construction industry, specialist department for thermal insulation, cold protection, noise insulation and fire protection]

- Technischer Ausschuss (TA) [technical committee]
  Roland Schreiner

IVPU (Industrieverband Polyurethan- Hartschaum e. V.)

- Technischer Ausschuss des Industrieverbandes Polyurethan-Hartschaum [technical committee of the industrial association for polyurethane rigid foam]
  Wolfgang Albrecht

ÜGPU (Überwachungsgemeinschaft Polyurethan-Hartschaum e. V.) [monitoring association for polyurethane hard foam]

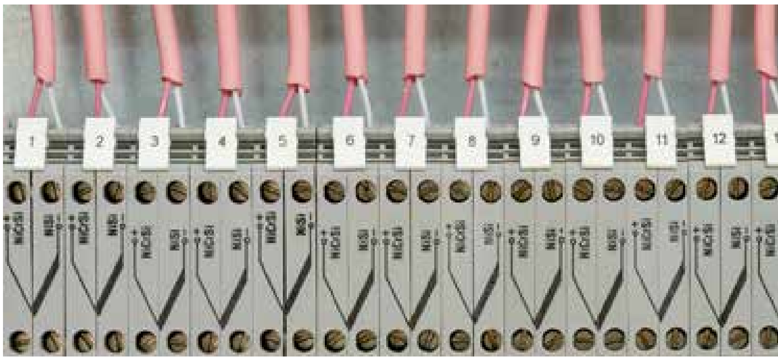
- Fachausschuss (Bewertung der Fremdüberwachungsergebnisse der ÜGPU) [expert committee (evaluation of external inspection results of ÜGPU)]
  Wolfgang Albrecht

VDI (Verein Deutscher Ingenieure e. V.) [association of German engineers]

- Fachausschuss „Wärme- und Kälteschutz VDI 2055“ [expert committee for thermal insulation and cold protection]
  Roland Schreiner (Obmann)
- Richtlinienausschuss VDI 4610 [regulations committee]
  Karin Wiesemeyer (Obfrau)
- Fachausschuss „Energieanwendung“ [energy application committee]
  Karin Wiesemeyer
- VDI-Gesellschaft Energie und Umwelt (VDI-GEU) Fachbereich 3 [VDI association for energy and the environment, specialist department 3]
  Roland Schreiner, Karin Wiesemeyer

DIN NABau (Deutsches Institut für Normung e. V.) [German standardization institute]

- NA 005-56 FBR „KOA 06 Energieeinsparung und Wärmeschutz“ [energy savings and thermal insulation]
  Andreas Holm (chairman) (Koordinierungsausschuss) [coordination committee]
- NA 005-56-10 AA „Dämmarbeiten an betriebstechnischen Anlagen in Gebäuden und in der Industrie“ [insulation work in operational systems in buildings and industry]
  Roland Schreiner
- NA 005-56-20 GA „Energetische Bewertung von Gebäuden“ (u. a. DIN V 18599) [energy-related evaluation of buildings, among others DIN V 18599].
  Andreas Holm
- NA 005-56-60 AA Wärmedämmstoffe (SpA zu CEN/TC 88, ISO/TC 163 und ISO/TC 61) [thermal insulation material (SpA for CEN/TC 88, ISO/TC 163 and ISO/TC 61]
  Andreas Holm (Obmann)
- NA 005-56-60 AA Wärmedämmstoffe [thermal insulation material]
  Wolfgang Albrecht
- NA 005-56-60, Ad hoc 04 EPS
  Stefan Sieber
- NA 005-56-60 AA, ad hoc 09 Holzwolleleichtbauplatten [cement-bonded wood wool panels]
  Stefan Sieber
- NA 005-56-65 AA „VakuumIsolationspaneele (VIP)“ [vacuum insulation panels]
  Christoph Sprengard
- NA 005-56-69 AA „Dämmstoffe für betriebstechnische Anlagen in Gebäuden und in der Industrie“ [insulation material for operational systems in buildings and in industry]
  Roland Schreiner (chairman)
- NA 005-56-90 HA „Wärmeschutz und Energieeinsparung in Gebäuden“ (SpA zu CEN/TC 89 und ISO/TC 163) (u. a. Normenreihe DIN 4108) [thermal insulation and energy savings in buildings (SpA for CEN / TC 89 and ISO / TC 163 (among others, standards series DIN 4108)]
  Andreas Holm (chairman)
- NA 005-56-92 AA Kennwerte und Anforderungsbedingungen Wärmedurchgang; Bemessungswerte der Wärmeleitfähigkeit (DIN V 4108-4) und Mindestanforderungen an Dämmstoffe (DIN 4108-10) [parameters and requirements for heat transfer; nominal values of thermal conductivity (DIN V 4108-4) and minimum requriements for insulation materials (DIN 4108-10)]
  Wolfgang Albrecht (chairman)
- NA 005-56-93 AA Luftdichtheit (SpA ISO/TC 163/SC1/WG10) [airtightness]
  Sebastian Treml
- NA 005-56-97 AA Transparente Bauteile (SpA ISO/TC 163/SC 1/WG 14) [transparent components]
  Christoph Sprengard
- NA 005-56-98 AA Wärmetechnisches Messen [thermal measurements]
  Wolfgang Albrecht
- NA 005-56-99 AA Feuchte (Sp CEN/TC 89/WG 10) [moisture]
  Andreas Holm
- NA 005-02-09 AA Abdichtungsbahnen (Sp CEN/TC 254) [sealing sheets]
  Sebastian Treml
- NA 005-02-91 AA Flexible Bahnen unter Dachdeckungen (Sp CEN/TC 254/WG 9) [flexible underlays below roof coverings]
  Sebastian Treml
- NA 005-02-92 AA Unterdeckplatten (Sp CEN/TC 128/SC 9/WG 5) [rigid underlays]
  Sebastian Treml
- NA 042-02-01 AA Faserplatten (SpA CEN/TC 88/WG 17) [fibreboards]
  Sebastian Treml



International committees and boards

CEN (Comité Européen de Normalisation)

- TC 88 Thermal Insulating Materials and Products
  Andreas Holm (Chairman)
- TC 88 / WG 1 General test methods
  Claus Karrer
- TC 88 / WG 1 General test methods – ad hoc group aging (fast aging procedures for XPS, PUR, PF)
  Wolfgang Albrecht
- TC 88 / WG 4 Expanded Polystyrene Foam (EPS)
  Stefan Sieber
- TC 88 / WG 4 / Drafting Panel
  Stefan Sieber
- TC 88 / WG 4 / TG ETICS
  Stefan Sieber
- TC 88 / WG 4/TG Test Methods and Test Result
  Stefan Sieber
- TC 88 / WG 7 Phenolic Foam
  Wolfgang Albrecht
- TC 88 / WG8 Cellular Glas (CG)
  Stefan Sieber
- TC 88 / WG 9 Woodwool (WW)
  Stefan Sieber
- TC 88 / WG 10 Building equipment and industrial installation
  Roland Schreiner (Convenor)
- Liaison officer with CEN / TC 88 and TC 166 Chimneys
  Roland Schreiner
- TC 88 / WG 10 Building equipment and industrial installation – Task group Test methods (TGTM)
  Roland Schreiner (TG Leader)
- TC 88 / WG 11 Vacuum-Insulation-Panels (VIP)
  Christoph Sprengard
- TC 88 / WG 12 Expanded Perlite Boards
  Wolfgang Albrecht
- TC 88 / WG 16 Evaluation of Conformity
  Roland Gellert
- TC 88/TG Liaison to TC 350/351
  Roland Gellert (Convenor)
- TC 89 Thermal performance of buildings and building components.
  Andreas Holm
- TC 89 / WG 14 Determination of thermal resistance at elevated temperatures using the guarded hot plate method
  Roland Schreiner
- TC 254 Flexible sheets for waterproofing
  Sebastian Treml
- TC 254 / WG 9 Underlays for discontinuous roof coverings
  Sebastian Treml (Convenor)
- TC 254 / TG WG 9 and 10 Artificial Aging
  Sebastian Treml (Convenor)
- TC 371 Project Committee on Energy Performance of Buildings
- Group of Notified Bodies-CPR / SG 19 Thermal Insulation Products
  Wolfgang Albrecht, Roland Schreiner

CEN (Comité Européen Certification)

- SDG 5 Thermal Insulation Products TG λ - Expert Group (creation of a uniform thermal conductivity level for insulation material in Europe)
  Wolfgang Albrecht

ISO (International Organization for Standardization)

- TC 163 Thermal performance and energy use in the built environment SC1
  Andreas Holm (Chairman)

QAC (Quality Assurance Committee)

- VDI-KEYMARK scheme for thermal insulation products for building equipment and industrial installations, the voluntary product certification scheme
  Roland Schreiner (Chairman)
- Laboratory Group
  Roland Schreiner

Other bodies

- Fachverband Innendämmung FV ID [professional association for internal insulation]
  Christoph Sprengard
- Vacuum-Insulation-Panels international Assoziation VIPA
  Christoph Sprengard
- International Vacuum-Insulation-Panels Symposium – Scientific Committee
  Christoph Sprengard
- Advanced Porous Materials Association ADVAPOR
  Christoph Sprengard

FIW Annual Report 2017

8 Thermal Insulation Day 2017

state secretary Jochen Flasbarth

from left to right: Dr. Anja Weisgerber, MdB, Dr. Julia Verlinden, MdB, Eva Bulling-Schröter, MdB, Stephan Kohler

Berlin – The German thermal insulation day of Forschungsinstitut für Wärmeschutz (FIW) e.V. München can now be referred to as a traditional event. After taking place in Munich for many years, for the second time now the EUREF campus in Berlin was the venue. About 100 participants from the areas of energy economy, construction, science, research and politics discussed this year's subject area of "Climate protection plan 2050 – The responsibilities of the building sector" in lectures and discussion rounds.

The German thermal insulation day 2017 was officially opened by the FIW chairman of the board Klaus-W. Körner. His core statement for the day was: "Without the building sector and, in particular, the existing building stock, the energy revolution which could not be dealt with until now and thus the achievement of the energy and climate-political targets cannot be realized". Mr. Körner added: "We failed to turn the energy revolution into the needed thermal revolution but made it an electricity revolution". The FIW chairman heavily criticized the Erneuerbare-Energien-Gesetz (EEG) [German law on renewable energy], which – according to him – has led to a significant misallocation: "Instead of providing incentive for energy savings, we rewarded energy generation, i.e. we have turned the world upside down with respect to one important precondition for the success of the energy revolution: efficiency first." In view of current events, Mr. Körner also discussed the London Grenfell tower fire disaster: "Building facades are insulated to improve the energy balance of houses and apartments. In this respect, the Bundesumweltministerium [German ministry for environmental affairs] has provided a clear statement: Due to the existing fire protection regulations, high safety standards must be complied with in Ger-

from left to right:
Thomas Bareiß, MdB, Christian Dürr, MdL

Prof. Andreas Holm

many. According to the ministry, such catastrophe can be ruled out if these regulations are complied with. Deutsche Umwelthilfe (DUH) [German environmental aid organization] also sees no safety gaps: In Germany, strict regulations apply with respect to insulating material in order to minimize the fire risk, Explained the DUH. While, in Germany, there is still room for improvement in some other areas, we are here looking better than the UK."

In his lecture, Prof. Dr. Ottmar Edenhofer, deputy director at the Potsdam-Institut für Klimafolgenforschung (PIK) e.V. [Potsdam institute for climate impact research], concentrated on the CO2 price. He claimed: "The CO2 pricing via taxes or the emission trading system must be enforced". Mr. Edenhofer was pleased that the creation of CO2 prices increased in the G20 states. He added that these prices need to be successively raised. According to him, this measure is even more important in view of the fact that fossil energy sources will remain cheap in the long run.

In his lecture, Jochen Flasbarth, state secretary at the Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit [German federal ministry for environmental affairs, nature conservation, construction and reactor safety] discussed the national implementation of the climate protection plan 2050. He pointed out that the German federal government still aims at achieving a climate-neutral stock of existing buildings until 2050. Here, the state secretary praised the social consensus in the Federal Republic of Germany: "Germany is a country that is enthusiastic about climate protection. We politicians always feel that the public supports our efforts in this respect. For the green house emission neutrality 2050, Mr. Flasbarth mentioned the sector objectives of the federal government.

Dr. Anja Weisgerber, MdB

Reinhard Müller

"We have already achieved 43% in the building sector; 67% is the objective for 2030". The state secretary believes that the future-proof energy mix consists of energy efficiency plus renewable energies which, however, are not available to an unlimited extent. On the other hand, Mr. Flasbarth believes that fossil heating systems have no future. In a self-critical manner, he admitted: "The additional investments in the building sector in this legislative period have not brought the expected results. In the next period, the tax promotion must be realized."

In his lecture, Thomas Silberhorn, MdB, member of the German parliament and parliamentary state secretary at the Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung [German federal ministry for economic cooperation and development] focused on climate protection from a development policy's point of view. For him and his ministry, the decarbonisation of cities in view of the rapidly increasing global population is the most important task. According to Mr. Silberhorn, here, the building sector is one of the "most important areas of action". He believes that the transfer of knowledge is of utmost importance here. In Mexico, the ministry promoted the development of an assessment system which is similar to the German "energy performance certificate". This resulted in 60,000 energy-efficient houses which saved 1.5 million tons of CO2 in 2016. The role of Germany in global climate protection is "immensely important" according to Mr. Silberhorn. The motto of his ministry is: "Live climate protection at home and promote it internationally". For "at home", Mr. Silberhorn is mainly in favor of a "significant reduction in energy consumption". "On average, we Germans consume as much energy in one month as the Senegalese need in one year and, in one year, we consume almost as much as electricity as all African countries put together". "We need to stop this", said Mr. Silberhorn; he added that Germany should act as a role model in the world and that it also has the necessary know-how for that.

The panel discussion on the subject of "Climate protection in the building sector– increasing the free market or increasing state government? – Viewpoints of the different parties on the occasion of the German federal election",

Prof. Ottmar Edenhofer

which was moderated by Stephan Kohler, the managing director of EnergyEfficiencyInvest Eurasia GmbH, was attended by members of parliament from all parties in the German parliament, except for the SPD, and a representative of the FDP from the federal state parliament of Lower Saxony. Thomas Bareiß for the CDU, Dr. Anja Weisgerber for the CSU, Dr. Julia Verlinden for Bündnis 90/Die Grünen, Eva Bulling-Schröter for DIE LINKE, and Christian Dürr for the FDP. Dr Anja Weisgerber regarded the "tax promotion for thermal insulation as the most important lever". Here, she was supported by her Union colleague Thomas Bareiß, who pleaded for more market incentives. "Every Euro that is promoted by taxes leads to investments of up to seven or eight Euro". Dr Julia Verlinden said that the German federal government "greatly failed in their climate policy". According to her, a reformation of the energy tax and pricing was long overdue and she demanded to immediately stop the KfW promotion for a heating replacement. Eva Bulling-Schröter highlighted the position of her party for a complete fossil fuel phase out. According to her, many citizens are afraid of a renovation of the energy sector; for this reason, the federal government would need to ensure "renovation schedules" and, generally, a better counseling, including and in particular for medium sized companies. Christian Dürr responded to the main question of the round for his party clearly with "increase in market freedom". According to him, an expansion of the emission trading system (ETS) is indispensable. Here, Mr. Dürr believes that there should be no minimum price. The party chairman of the FDP in the Landtag of Lower Saxony summarized the opinions of the discussion as follows: "In their individual election campaigns, every party had different instruments and concepts with respect to climate policy; however, everyone had the same goal: improvement of climate protection".

The final chord at the German thermal insulation day was set by the head of the institute of FIW Prof. Dr. Ing. Andreas Holm, who reminded everyone about the "huge potential" in the building stock: "75% of all buildings in Germany are currently in need of renovation". The question of whether today's technologies are capable of achieving the energy objective for 2050, which was central to the entire event, was clearly answered by Mr. Holm: "Yes, everything has been invented". For the implementation to be successful, however, the FIW managing director sees three obligatory factors: First, an improvement of thermal insulation, second, a replacement of old heating systems and, third, an energy revolution and not just an electricity revolution as has been the case up to now.

In the end of the day, all participants agreed on the importance of events like the German thermal insulation day, which should not only take place in years of a German federal election.

The cooperation partners of this year's German thermal insulation day were the Deutsche Bauindustrie [German building sector], BUVEG – Die Gebäudehülle [association for the building envelope], Deutsche Energieberater-Netzwerk e.V. [German energy consultants' network], Deutsche Energie-Agentur dena [German energy agency] and Gesellschaft für Rationelle Energieverwendung e.V. GRE [society for rational energy use]. The FIW would like to thank its partners as well as the BASF and Qualitätsgedämmt e.V.

For further information, please refer to:
www.waermeschutztag.de

Basics

This year's research conference of the Forschungsinstitut für Wärmeschutz e.V. München took place at the Haus der Bayerischen Wirtschaft on May 17. On this day, 150 participants followed 12 compelling lectures. The scientists of the institute provided insights into the latest results from their fields. The slogan of this year's research day was "Forschung für die Wärmewende" [research for a heat revolution]. The FIW discussed the question whether the climate protection objective for 2050 can be achieved with today's technologies.

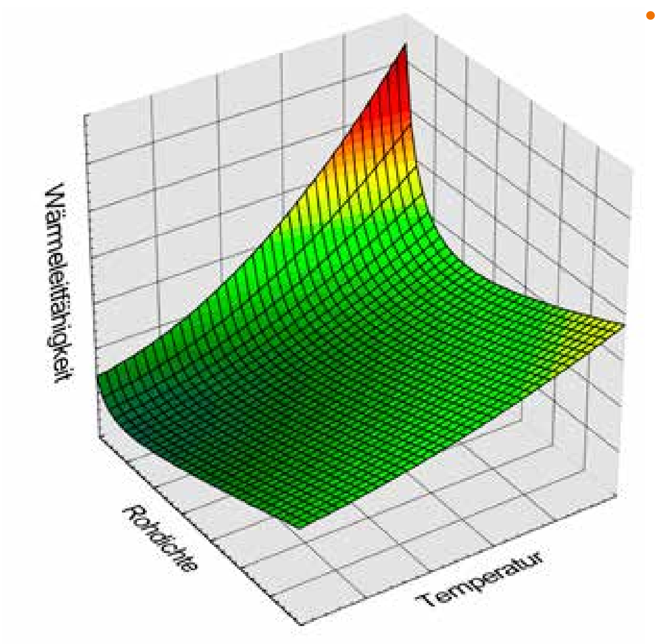


Image 1: Impact of the temperature and the raw density of the insulating material on thermal conductivity

Roland Schreiner

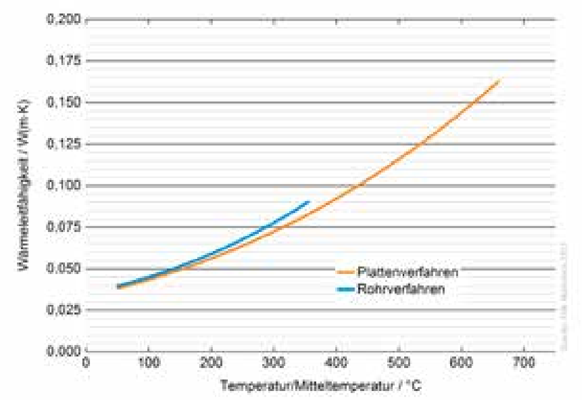
Temperature-dependent thermal conductivity of insulating materials, basics and impacts
Roland Schreiner

All insulating materials have a thermal conductivity which more or less depends on temperature. Based on the different heat transfer mechanisms in the insulating material, in particular the conduction and radiation, the impact of the parameters temperature and gross density on the thermal conductivity can be shown in detail (image 1). In case of insulating material for high-temperature applications, the heat transfer by radiation is the dominant mechanism for energy transfer. This means that knowledge of the thickness effect for radiation-permeable insulating material is of great importance when it comes to the determination of the thermal conductivity in the laboratory according to the European test standards. By means of appropriate, radiation blocking additives, these insulating materials can be optimized. For thermal insulation calculations regarding the insulation of building equipment and industrial installations, the operational thermal conductivity including the application-specific mark-ups is the decisive parameter. If the temperature differences in the applied state on the insulating material used significantly exceed the temperature differences during the determination of the thermal conductivity in the laboratory, the design of insulation systems is to be based on the integral mean value of the thermal conductivity. The nominal values of thermal conductivity declared by the manufacturers of insulating materials can be externally inspected via voluntary quality assurance systems (e.g. VDI / KEYMARK) on a continual basis and thus provide an additional safety level for designers.

Robert Hofmockel

Temperature-dependent thermal conductivity of insulating materials – metrological determination
Robert Hofmockel

Thermal conductivity in the area of building services almost always refers to the value at a temperature of 10 °C. In technical insulation, this information is insufficient since the temperature varies in many applications, e.g. from -160 °C for liquid gas application to 600 °C in ovens and boilers. In two-plate units which have been specifically developed for low and high temperatures, the thermal conductivity can be determined depending on the temperature. Here, the measurement takes place with a small temperature difference; as a result, one receives the thermal conductivity of the tested material for a specific temperature. This is opposed by the measurement in pre-formed tube insulating materials, which are produced in the factory as tubes, segments or pipe shells. The thermal conductivity is measured in a manner that is comparable to practical applications with great temperature difference at the insulating material; as a result, the heat conductivity



Images 2 Increased thermal conductivity due to great temperature difference during the measurement in the pipe procedure compared to the plate procedure for an insulating material

is obtained as integral mean value of a specific mean temperature. This means that the values of thermal conductivity of even products (plate procedure) cannot be directly compared to those of pre-formed pipe insulating material (pipe procedure) (image 2).
The measurement uncertainty consists of the same parameters in both procedures: when looking at the formula for the thermal conductivity, the physical parameters of temperature, dimensions, current and voltage can be found. The temperature measurement contains the main part of the measurement uncertainty of approximately two thirds, followed by the determination of the sample thickness and the measurement of the electrical output of voltage and current. In addition to the classic measurement uncertainties, however, the so-called systematic errors need to be observed as well, e.g. the border losses or the contact resistance between the measurement area and the sample surface.

The measurement of the temperature-dependent thermal conductivity still has enormous potential for further development in the expanded temperature area to continuously improve the quality of measurements. Here, FIW München is strongly involved with own concepts.

Max Engelhardt

Free convection in fiber insulating materials – background and practical effect

Engelhardt Max

The phenomenon of natural convection drives our oceans and is responsible for the formation of clouds and the movement of the continental plates. It arranges cooling lava flows and thus created the impressive basalt formations. But it is also in comparatively small systems such as living spaces, radiators and cooking pots that natural convection functions as a decisive effect mechanism.

In the general teaching of building physics, convection is considered in many aspects. Examples are the thermal evaluation of air layers in constructions, the calculation of the heat transfer between components and the environment, examinations regarding comfort and room air quality and heating concepts. The free convection in air-permeable insulating materials, however, is generally only mentioned incidentally with purely qualitative statements such as that, with very low gross densities of the insulating material, convection can occur. Is the phenomenon of free convection in the area of building construction insulating material therefore not even relevant in practice?
The speech is intended to provide an introduction to the subject and focuses on the heat-related effects of convection on insulations in vertical building construction components.

A short examination of the physics regarding the emergence of natural convection shall answer the question as to when convection effects could lead to an increase in heat loss through an insulated component. Here, it is shown that air circulation in an insulation layer does not necessarily need to lead to increased heat losses.
The main impact factors on convection effects, in particular the substances involved (air and porous medium), the dominating boundary conditions (temperatures and temperature differences), and the system boundaries (component geometry and air-tight levels) are discussed here. For this purpose, selected publications as well as own research of FIW München supporting the understanding of convection currents in fibre insulating material are presented.

Concludingly, the consideration of convection effects in insulating material within the framework of existing regulations by the specifications in the pivotal international standard for thermal design values – ISO 10456 – is presented and a practical conclusion from the users' point of view is drawn.

Super-insulating materials

Sebastian Treml

Thermal conductivity measurements in super-insulating materials – What is to be taken into consideration?
Dr.-Ing. Sebastian Treml

Literature does not provide an unambiguous definition of super-insulating materials. Therefore, in general, materials with an extremely low thermal conductivity can be designated super-insulating material. A possible more precise definition subsumes materials which eliminate the thermal conductivity of the cell gas by means of the so-called Knudsen effect under this term. Generally, this refers to two material groups – vacuum insulation panels (VIP) and advanced porous materials (APM).

The thermal conductivity of VIP of approx. 0.002 – 0.007 W/(m·K) is approximately by factor 10 lower than the thermal conductivity of so-called conventional insulating material such as mineral wool or EPS. APM reach values in an area of approx. 0.015 – 0.020 W/(m·K). Due to the very low thermal conductivity, thin insulation thicknesses can be realized accordingly. The common thickness range of VIP lies between approx. 20 to 30 mm. In some cases, thinner panels may also be used.

The determination of very low heat flows in connection with lower panel thicknesses can lead to increased measuring uncertainties when it comes to the determination of thermal conductivity. In the speech, therefore, calculations on the combined standard uncertainty in the determination of the thermal conductivity of super-insulating materials with the guarded hot plate apparatus, assuming typical measuring uncertainties according to DIN EN 1946-2, are presented. Recommendations for the measurement of the thermal conductivity of VIP and APM are derived from the results.

Susanne Regauer

New method for the determination of the internal pressure of vacuum insulation panels (VIP)
Susanne Regauer

The internal pressure of vacuum insulation panels (VIP) is decisive for the lower thermal conductivity of these insulation materials and thus an important parameter for the assessment of the quality of panels. For the measurement of the internal pressure of the vacuum insulation panels, the most frequently applied method is the foil lift-off procedure. Here, the VIP is positioned in a vacuum chamber and the pressure in the chamber is continuously lowered by means of vacuum pumps. During the evacuation process, the internal chamber pressure and the movement of the surface of the VIP envelope are recorded. If the internal chamber pressure undercuts the internal pressure of the VIP, the envelope foil is lifted off the core; this process is recorded by the laser distance sensors. By means of suitable evaluation procedures, the internal pressure of the VIP can be calculated based on the functional relation between the translation of the monitored position of the foil and the recorded internal chamber pressure.

This indirect measuring procedure is currently still without verification or reference measurements with a direct method. In order to check the correspondence of the measurements of the lift-off processes of the foil from the core to the actual internal pressure and to define boundary conditions for the measurements, this project was carried out at FIW München by order from Vacuum Insulation Panel Association (VIPA International).

Initially, the framework conditions for the measurement of the internal pressure with the foil lifting procedure were defined. For this purpose, numerous factors impacting the measurement results were examined in comprehensive measurements series, such as the impact of the support of the VIP in the chamber, the number and positioning of the laser distance sensors for monitoring the movements of the wrapping foil and the control of the internal chamber pressure with respect to the pressure drop rate and the intermediate ventilation. These parameters impact the result and can make the evaluation of the obtained raw data more difficult.

With this modified measurement assembly, measurements for the validation of the foil lift-off procedure were implemented. Specifically produced test specimens with adapters for penetrating the panel cover enable the simultaneous measurement of the internal panel pressure, the foil movement, and the corresponding internal pressure of the vacuum chamber. Based on this, the relationship between the three measured parameters can be derived.

Practical heat and humidity protection

Karin Wiesemeyer

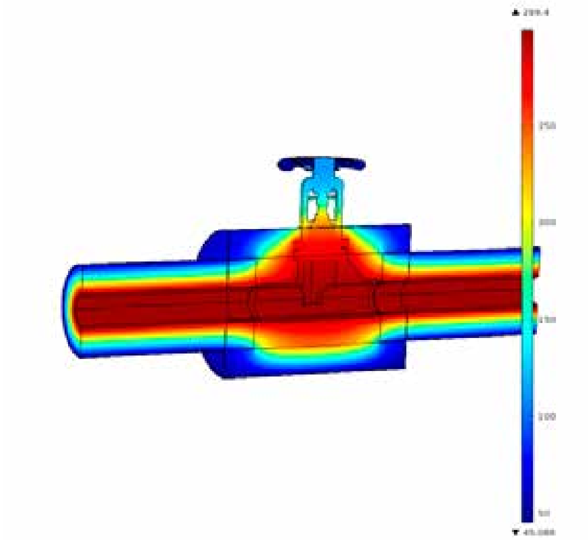


Image 3: System-caused thermal bridges (e.g. valve)

Thermal bridges for technical insulation – significance, requirements, and practice

Karin Wiesemeyer

Both in operational systems as well as in building services, many thermal bridges are non-insulated or only insufficiently insulated. This circumstance has a high potential for savings with respect to technical insulations.

To be able to assess this potential for savings, the thermal bridges catalogue for technical insulations was created based on the regulation VDI 4610, sheet 2. Here, formulas for conventional types of fittings and flanges as well as calculation tools for the system-specific thermal bridges such as supports and suspensions are listed (image 3).
Thermal bridges in technical insulations are subject to both operational and legal requirements. Operational requirements are, for instance, the reduction in the heat loss, the compliance with the surface temperatures or the guarantee of functionality. Certain legal requirements are provided by the Energieeinsparverordnung [German ordinance on energy savings]; additionally, the energy efficiency classes of regulation VDI 4610, sheet 1 stipulate framework conditions.

Based on the example of a flange cap, the savings potential becomes clear: A non-insulated flange of the dimension DN 32 with a medium temperature of 60 °C has a heat loss of approximately 22 W. If this thermal bridge is insulated, savings of 65% to 80%, depending on the construction type of the insulation cap, can be achieved.
Another example investigates the loss of thermal bridges compared to the thermal losses in a detached house. With 10 non-insulated thermal bridges in building services in the non-renovated detached house, the heat loss via the thermal bridges is at approximately 5%. For a renovated house, the ratio caused by 10 non-insulated thermal bridges increases to 18%.

Completed renovation projects showed that the costs of insulation of standard components are usually amortized within 2 to 3 years.

The thermal bridge catalogue for technical insulation (regulation VDI 4610, sheet 2) has been published as green print.

Florian Kagerer

Building stock and building model for Germany
Florian Kagerer

In the framework of the development of the climate protection plan of the German federal government, based on the reference scenario, two further target scenarios with the respective focal points of increasing the energy efficiency and/or further developing renewable energy were examined with respect to their technical and economic feasibility.

The results show that, based on both scenarios, the climate-related targets, i.e. a reduction in the greenhouse gas emissions by 80 - 95% until 2050 can be achieved. With their topical focus (efficiency, renewable energy) with respect to the complexity of the transformation of the energy system, the scenarios represent a strong simplification and are not suitable for describing and deriving the micro- and macro-economic effects for all relevant actors (energy producers, manufacturers, users, etc.).

In cooperation with other research partners, calculation methods and tools for examining various open-technology transformation paths and developing a technology and energy mix which is optimized with respect to the cost-benefit ratio for the building envelope, building, supply and energy systems are currently being developed. The cross-sector integral approach here allows deriving cost-efficient scenarios for transforming the overall energy system for defined framework conditions. Thus, both policy-makers as well as the industrial sector would be provided with a tool for checking and analysing climate strategies and developments of products, services, and business models in the context of possible future developments.

Therefore, FIW München was commissioned with the task of developing a building model for Germany as a main component of the tool. The current data of existing buildings, which is grouped according to building type (detached houses, apartment buildings, non-residential buildings), construction year category, and energy related condition, serves as basis. Development scenarios on new construction, demolition, and renovation are mapped and applied in the calculations for the time until 2050. Together with the modules of building supply and the energy systems, an overall model is created based on which the transformation paths for the years of 2025, 2030, 2040 and 2050 are described and the effects on the corresponding energy requirements (primary, final energy, and useful energy requirement), emissions (CO2, greenhouse gas emissions), and the macroeconomic costs can be determined and analysed.

Christoph Sprengard

Economic and ecological optimum of the future nearly zero energy building stock (NZEB)

Christoph Sprengard

The climate- and energy-political targets of the German federal government and the EU prescribe strict requirements towards the future energy standards for new buildings. These include strict provisions regarding the quality of the building envelope and the overall primary energy requirement of the building while maintaining the efficiency rule ("cost-optimized level").

Together with the Arbeitsgemeinschaft für zeitgemäßes Bauen (ARGE//eV) [working group for contemporary construction], FIW München has implemented a study for the Deutsche Gesellschaft für Mauerwerks- und Wohnungsbau (DGFM) [German society for masonry and residential construction] to examine the framework conditions and an economic energy level for future detached houses in the zero-energy construction method and define a recommendation for the political discourse.

For this purpose, a large number of different versions for all external components on different energy levels are combined with six selected building equipment technologies and the transmission heat losses and the primary energy requirements are determined in calculations as per DIN V 18599. For all components and technologies, the energy parameters were then compared to the costs for the investment and the ongoing costs.

The results of this study can be summarized as follows: With respect to the examined construction material for the outer wall, it can be said that, in the future, it will still be possible to meet the planned EU zero energy standard with the existing and established masonry constructions, i.e. masonry constructions will be future-proof even with increasing energy efficiency. However, the energy savings of the planned standards are insufficient for compensating the necessary additional costs for the zero energy building standard (EH 55). Without additional funding, the implementation is not economically efficient for the builder. It can be assumed that buildings according to the EU zero energy building standard will become more expensive compared to the statutory standard as per EnEV 2016 [Energieeinsparverordnung, German energy savings ordinance]. The envisaged requirements regarding the primary energy demand require a further increasing share of renewable energy in the supply of buildings, which will lead to a change in the building equipment technology: Heat pump, solar thermal energy, ventilation heat recovery increase the efficiency but also make the supply technology more expensive. The continued freedom of choice between different combinations of efficiency measures with which the future standards are generally technically fulfilled if the regenerative fractions are applied correspondingly is important for planners and builders. However, this means that the openness of technology is only partially given since some systems will only be possible with the increased solar coverage or in connection with a significantly improved envelope. For instance, proven standard technologies (e.g. the condensing boiler) will no longer be able to meet future limitations without additional expensive measures (e.g. solar heating support, ventilation heat recovery, biogas, improved building envelope) and thus lead to relevant additional costs.

For the political discourse regarding the adaptation of the energy savings directive, in particular, the following three recommendations can be provided. The previous evaluation and accounting parameters have proven themselves and shall be maintained. The optimum for the energy and the economic quality of the future zero energy buildings which was found in the research project results in the demand for a slightly moderate tightening of the previous requirements by no more than 10%. By doing so, KfW-Effizienzhaus 55 [KfW energy efficient house] could be maintained as a level of government aid, which would no longer be possible with a statutory demand for the establishment of this standard. Thus, the expected increases in costs could at least be partially compensated.

News from standardization, certification, and quality monitoring

Stefan Sieber

Wolfgang Albrecht

What are the requirements towards EIFS insulating materials?

Stefan Sieber

In external thermal insulation composite systems (ETICS), the insulating material is of central importance for the characteristics of this type of external wall cladding. It is an essential factor in determining the physical characteristics of the system and, as plaster base, contributes to the structural stability.
Different types of insulating materials, for each of which a separate set of characteristics parameters is used for verifying the suitability in ETICS, are utilised. The requirements towards the various types of insulating materials heavily depend on the application and the interaction with the chosen method of attachment and the plaster system. Therefore, no uniform requirements to the different types of insulating material in an ETICS exist.
To date, ETIC systems have been regulated via national or European approvals, supplemented by national application regulations. Currently, a standard which covers the majority of the currently available systems and applications is being created. Suitable insulating materials are described based on characteristics parameters. These are to be ensured in the framework of initial type tests and regular checks. The certifications can be provided by the insulating material manufacturer, possibly in cooperation with the recognized certification bodies. The certifications required according to various technical rules are very similar. Thus, the largest part of the required verifications can be received via voluntary certification systems, initially largely independent from the concrete technical rule.

Are the current voluntary certification systems of the FIW an adequate replacement for the previous regulations?

Wolfgang Albrecht

In the wake of the implementation of the decision of the European Court of Justice, it became clearer and clearer that, after a transition period, only voluntary certification systems can be used for the verification of the quality of construction and insulating material.

Last year, FIW München further developed a series of voluntary certification programs and made them ready for application. This includes the European Insulation Keymark System 2.0, which is offered by the FIW for mineral wool, XPS, EPS, and WW insulating material. In cooperation with ÜGPU Stuttgart [Qualitätsgemeinschaft Polyurethan-Hartschaum, qualityassurance association for polyurethane hard foam], a certification program for PU insulating material is offered. Since 2016, FIW München also offers certification programs for ETICS insulating materials. The core of all these certification systems is the independent control of the production process and the factory-internal production control with calibration and comparative tests. With respect to product tests, there are large differences between the test scope, product certification, and characteristics certification.

It is important that these certification systems can be combined with each other and that new possibilities are created with respect to the European inspection bodies, test institutes, and certification bodies. Additionally, the connecting line to the application needs to be drawn at all times.

Claus Karrer

What is the current and future performance level of certification programs?
Claus Karrer

With the introduction of the Construction Products Regulation (CPR), the focal point of the national regulations moves further away from the construction product and towards the construction itself. This means that there is an increased responsibility when it comes to the selection, use, and provision of suitable construction products for all parties involved in the erection of a building, such as builder, planner, construction company, and construction material dealer. Here, certification programs can meet the increasing demand for reliable verifications of the product quality and create trust in construction products.

The “quality pyramid” of FIW München helps with the selection of suitable certification basis for thermal insulating material. While “quality levels 5 and 4” only reach the minimum requirements according to CPR and can largely be fulfilled with the manufacturer’s declaration, levels 3 to 1 represent voluntary certification programs in which the product quality is comprehensively confirmed by means of a neutral, independent certification body.

With respect to the scope, costs, and product safety, the FIW-Z programs in level 2 correspond largely to the previous application approvals by the construction supervisory bodies for ETICS insulating materials (Z-33.4-xxxx) or for perimeter applications (Z-23.33-xxxx). KEYMARK as certification program by CEN poses less strict requirements with respect to testing frequency for the group certification, which is common practice in the area of construction. A significantly greater product safety is provided by the expanded certification program of FIW with supplementary measures such as additional unannounced product sampling, additional testing of core characteristics, and special tests twice a year.

The increasing demand for proofs of quality by means of certification programs can be observed for thermal insulating materials which are used as component in other construction products or insulation systems. This applies to the utilization in a construction set (e.g. ETICS), in a construction product according to CPR (e.g. sandwich elements according to EN 14509 with quality regulation of EPAQ), or to application in an insulation system (e.g. internal insulation).

Recommendations of national associations of insulating material manufacturers regarding the implementation of certifications (ÜGPU, FMI, FPX, VHD) could be expanded to a European level in the future (VIPA already globally) in order to support a fair European market environment.
Supply agreements regarding the product quality based on certification programs between construction product manufacturers and construction material dealers or craftsmen associations can help to guarantee a high product safety in the future. Additionally, existing requirements of laws or for government aid measures may also be transferred to thermal insulating materials according to certification (example: Requirements of EEWärmeG [Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich, German law on the promotion of renewable energies in the thermal area] - according to "Solar KEYMARK" certification for solar thermal systems).

FIW München works together with the leading European certification bodies for thermal insulation to achieve mutual recognition and to (further) develop European certification programs, e.g. KEYMARK. We are always happy to hear comments, ideas, and wishes from the entire field of construction. Don't hesitate to contact us!

Roland Gellert

Emissions from construction products: State of European standardization
Dr. rer. nat. Roland Gellert

With the publication of the change in mandate M/103 in June 2010, the European Commission commissioned the CEN with supplementing the insulating material standards (hENs published in OJ) by the basis work requirement 3 "hygiene, health and the environment" since ".. insulating materials may release or contain substances which are classified as "hazardous substances" according to EU and national regulations". The European Commission here refers to the following requirements:

- Hazardous substances database of the European Commission (http//ec.europa.eu/enterprise/construction/cpd-ds)
- Indicative list of indoor air/soil and (ground) water (DS 051)
- Annexes to the change in the mandate (remark: national regulations in a "matrix")

For the dialog with the CEN/TC 88 "thermal insulating materials and products" (and other TCs), the European Commission founded an "Expert Group Dangerous Substances (EGDS)" headed by Manfred Fuchs. This group demanded the creation of "technical dossiers (TD)" from the TC 88 in accordance with a questionnaire for all product standards created in hENs so that detailed information on production procedures, ingredients, and use would create additional transparency – beyond hENs. The "Dangerous substances" task group of TC 88 has meanwhile delivered these TDs and received feedback from the European Commission.

In parallel, by order of the European Commission (mandate M/366), the CEN/TC 351 created necessary testing procedures:

- prEN 16516 " …Determination of emissions into indoor air" (the "formal vote" is currently ongoing)
- prTS 16637, part 2 " …. Horizontal dynamic surface leaching test"
- prTS 16637, part 3 " …. Horizontal up-flow percolation test"

The parts of the prTS 16637 are testing procedures for construction material which are in contact with the soil or with (ground) water (e.g. perimeter insulation). Robustness tests for these testing procedures still need to be carried out. With their testing and analysis equipment, FIW München is able to carry out examinations according to prEN 16516. With the publication of quotable test standards and the accepted technical dossiers, the TC 88 must now present a work program for the integration of the expanded mandate order in hENs.

Towards the end of 2016, the European Commission presented a draft for a delegated act, in the technical annex of which the classifications of emissions according to four criteria are listed:

- Sum of VOC – emissions EU – LCI – ratio
- Formaldehyde – emissions
- Emissions of carcinogenic substances

Currently, the coordination process with the member states is ongoing. Additionally, the criteria according to which the "WT/WFT" options (with testing/without further testing) are granted must be clarified.

The lecturers of the FIW Research Day

Presentation documents can be downloaded at:
www.fiw-forschungstag.de

Events, seminars, exhibitions

For many years, FIW München has been successfully organizing seminars on the subject of thermal insulation and protection against cold in operational systems. In addition to the trainings for insulating material manufacturers in the building of the institute, this year, seminars and trainings were conducted at system manufacturers in the area of power plant technology. The contents can be individually adapted to the wishes and requirements of the customers. The trainings include the principles of heat transport and heat transfer as well as calculations and application examples. The impact of moisture and thus corrosion under the insulation and economic efficiency calculations in times of long-term increases in energy prices are vividly presented to the training participants. Lastly, insights into the related standards, regulations and work sheets as well as product specifications are helpful and round off the subject area.

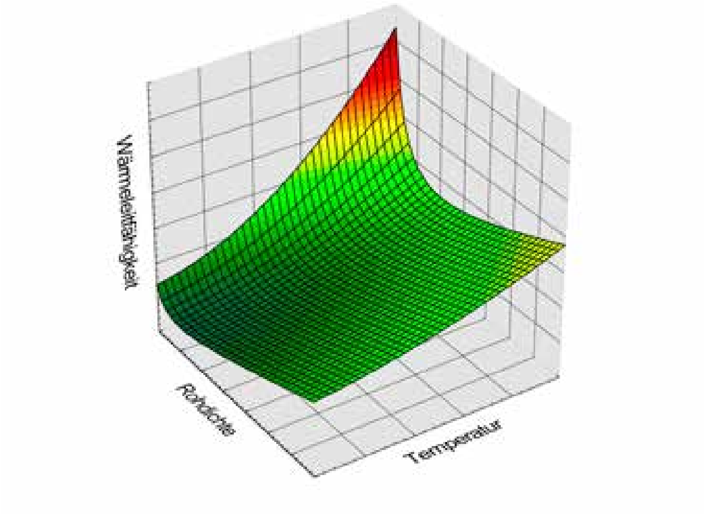


Image 1: Thermal conductivity of insulating materials depending on temperature and density

Seminars

The European Industrial Insulation Foundation (EiiF) offers a procedure with which the optimisation potential in industrial systems can be uncovered: The TIPCHECK (Technical Insulation Performance Check) aims at increasing the ecological and economic performance. The TIPCHECK Is implemented by specially trained and certified TIPCHECK engineers and includes the following steps:

- Inventory
- Analysis
- Consultation
- Calculation of measures

Here, system components are photographed with a thermal imaging camera, which provides insights into the weak points in the existing insulation. In the following step, detailed analyses form the basis for a comprehensive consultation, which, in addition to specific technical measures, also highlights cost-relevant aspects. An efficient insulation not only saves energy and money and reduces emissions, it also has a positive effect on process control and workplace safety.

In 2017, EiiF continued to conduct their TIPCHECK courses at FIW München.

Here, the institute not only provides the rooms but also supports the event in the practical exercises on the wall testing facility, the so-called “boiler wall”.

Thanks to the comprehensive stock of insulating material samples of FIW München, material science can be vividly demonstrated. The various measurement principles, for instance in temperature measurements, can be practically trained with the FIW testing devices.

Contact: Roland Schreiner and Marie Bernthaler

TIPCHECK eiif

Image 2: TIPCHECK - EiiF logo

Image 3: Tipcheck participants

Image 4: VDI lecture by Mr. Schreiner

"Wärme- und Kälteschutz an betriebstechnischen Anlagen gemäß VDI 2055 Blatt 1:2008"
Training in calculation principles – Design of insulations
Seminar in November 2017

Contact: Roland Schreiner

Training in the operation of a two-plate apparatus for determining the thermal conductivity with higher temperatures
Seminar in September 2017

Contact: Roland Schreiner

Teaching and lectures

Prof. Dr.-Ing. Andreas H. Holm
„Basics of construction physics "
Munich University of Applied Sciences

"Energy Performance of Buildings" in the framework of the international Master program "Building Sustainability"
Technical University of Berlin

„Dynamisches hygrisch-thermisches Verhalten von Gebäuden" in the framework of the Master program in construction engineering and environmental engineering
Technical University of Munich

Speeches

Sebastian Treml

- “Calculation of increase of thermal conductivity according to differing climatic influences” 13th International Vacuum Insulation Symposium (IVIS 2017), Paris, France from September 20 to 21st, 2017.

Christoph Sprengard

- “Ökologisches und ökonomisches Optimum des künftigen Niedrigstenergiegebäudestandards (NZEB)” at the FIW München research day in Munich on May 17, 2017
- “Overall thermal performance of VIP: Comparison of Hot-Plate measure-ments (GHP and HFM), Hot-Box measurements and numerical simulations“ at the International Vacuum Insulation Symposium IVIS 2017 in Paris on September 20, 2017
- “Vacuum-Insulation-Panels (VIPs) for Buildings – From Research into Market” at the AMANAC workshop on “Energy Efficient Buildings“ in the framework of the ASHRAE Hellenic Chapter Conference in Athens on October 21, 2017.
- “Innovative Vacuum-Insulation-Panels (VIPs) for the use in the building sector – INNOVIP“ at the Clustering Event for Horizon 2020 held at Bayerisches Staatsministerium für Wirtschaft [Bavarian state ministry for economic affairs] in Munich on November 16, 2017.

Andreas Holm

- “Kosten versus Energieeffizienz: Optimierung von Niedrigenergiehäusern für die EnEV 2021“ – Munich construction trade fair on January 15, 2017
- “Dämmstoffe im Flachdach und erdberührten Anwendungsbereich” – 13th IFB Symposium in Vienna on February 02, 2017
- „Innovative Gebäudehülle“ – geea general meeting in Munich on March 22, 2017
- „Nachhaltigkeit von Systembauten“ – Knauf factory days in Iphofen on March 24, 2017
- “Wärmeschutz: eine Jahrhundertaufgabe” – Festive event: university prize of the Bavarian construction sector in Munich on April 4, 2017
- “Können wir mit den Technologien von heute die Energieziele 2050 erreichen?” – German thermal insulation day in Berlin on June 20, 2017
- “Kosten versus Energieeffizienz: Optimierung von Niedrigenergiehäusern für die EnEV 2021“ – Entrepreneurs’ day of the brick work group in Würzburg on July 05, 2017
- “Innovation in the ETICS market – How technical progress supports achieving major goals“ – EAE Etics Forum in Warsaw on October 05, 2017
- “Wärmeschutz im Kontext der Energiewende” – 50th anniversary of Poroton in Burghausen on October 09, 2017
- “Vorstellung der geea-Gebäudestudie” – in Berlin on October 16, 2017
- “Entwicklung neuer Dämmstoffe-zukunftsweisende Innovationen oder Sackgasse?” - Advanced porous materials - aerogels - symposium at Creavis in Marl on October 25, 2017
- „Rolle von energetischen Standards bei den Baukosten“ – evening event on the subject of profitability of energy efficiency: Controversies in Gebäudeenergiegesetz (GEG) [German buildings energy law]” – Deutsche Umwelthilfe (DUH) in Berlin on November 09, 2017
- “Gebäudebestand und Gebäudemodell für Deutschland“ – dena congress 2017 in Berlin on November 21, 2017
- “Wann lohnt sich dämmen?” – Old buildings fall forum in Stuttgart on November 22, 2017

10 FIW München in words and writing

Publications

Quenard, D.; Treml, S.; Sprengard, C. (2017):
Thermal Characterization of Super-Insulating Materials SIM – Current Project: EBC Annex 65. In: EBC Newsletter June 2017 Issue 65, Paris, 2017

Albrecht, W. (2017):
Qualitätsversprechen am Bau. mikado-Interview. Zeitschrift mikado 1-2.2017

Albrecht, W. (2017):
Die Nachweiskette muss schriftlich belegt werden. dachbau magazin 1-2/2017

Schreiner, R. (2017):
Energieeffizienzklassen der VDI 4610 – Beispiel Rohrdämmungen in der EnEV. Bauphysik 2/2017

Schreiner, R. (2017):
Insulation Keymark, Europäische Qualitätssicherung von Dämmstoffen ohne Handelsbarrieren. Deutsches Ingenieurblatt 6-2017

Wiesemeyer, K. (2017):
Vergleich der Berechnungsmethoden von VDI 2055, EN ISO 12241 und ASTM C 680. Bauphysik 2/2017

Gertis, K.; Holm, A. (2017):
40 Jahre Wärmeschutzverordnung. Bauphysik 6/17

Holm, A. (2017):
Energiewende im Gebäudesektor: „Ein Weiter-wie-bisher reicht nicht!“. Deutsches Ingenieurblatt.
Issue 12-2017 December. Page 3

Holm, A. (2017):
Gebäude-Energie-Gesetz gescheitert! Und nun?. Deutsches Ingenieurblatt.
Issue 06-2017

Image 5 – Prof. Dr.-Ing. Andreas H. Holm at the expert presentation of the study by geea, dena and industry associations on the energy transition in the building sector on 17.10.2017. Picture source: dena

FIW in the media

In the framework of interviews, statements and declarations, among others, the FIW was cited and/or mentioned in the following newspapers, magazines and brochures.

Prof. Dr.-Ing. Andreas Holm und Florian Kagerer
Wissenschaftliche Gutachter der Gebäudestudie „Szenarien für eine marktwirtschaftliche Klima- und Ressourcenschutzpolitik 2050 im Gebäudesektor"; Deutsche Energie-Agentur GmbH (dena). 10/2017

Prof. Dr.-Ing. Andreas Holm
Baustoffmarkt, issue 11/2017, page 27

Prof. Dr.-Ing. Andreas Holm
Energetische Gebäudesanierung – Fragen und Antworten zur Wirtschaftlichkeit, Deutsche Umwelthilfe, Stand 04.10.2017

Prof. Dr.-Ing. Andreas Holm
Raffiniert, IWO-Fachmagazin für den Wärmemarkt, issue 04/2017

Prof. Dr.-Ing. Andreas Holm
Baustoffmarkt, issue 4/2017, page 39

Prof. Dr.-Ing. Andreas Holm
Gemeinsam Werte Schaffen – Ein Unternehmen im Zeichen der Nachhaltigkeit; Festschrift 90 Jahre Karl Bachl GmbH & Co. KG

Prof. Dr.-Ing. Andreas Holm
Frankfurter Allgemeine; no. 56/10D1 of 07 March 2017

Prof. Dr.-Ing. Andreas Holm
Frankfurter Allgemeine Sonntagszeitung-Verlagsspezial Wärmedämmung of 15 October 2017

Seminar papers, Bachelor and Master theses

In cooperation with the Technical University of Munich (TUM) and the Munich University of Applied Sciences, we supported the following theses in 2017:

Lukas Berger
"Numerische Berechnung von Wärmebrückeneffekten an der Stoßstelle von Vakuum-Isolations-Paneelen (VIP) - Inklusive Parameterstudie unterschiedlicher Einflussgrößen und Vergleich verschiedener messtechnischer Methoden".
Technical University of Munich(TUM), department of civil, geo and environmental engineering; construction physics; Master thesis

Susanne Regauer
"Validierung des Folienabhebeverfahrens zur Innendruckmessung von Vakuumisolationspaneelen - Bestimmung des Innendrucks von Vakuumisolationspaneelen (VIP) mit Kieselsäurekern mittels direktem und indirektem Messverfahren".
Technical University of Munich(TUM), department of civil, geo and environmental engineering; construction physics; Master thesis

Chiara Cucchi
"Analysis of measurement uncertainty for determination of thermal conductivity on Super Insulation Materials" POLITECNICO DI TORINO;
Facoltà di Ingegneria; Corso di Laurea in Ingegneria Edile; Tesi di Laurea Magistrale (Master thesis)

11 By the way...

From theory to practice – Applied sustainability at FIW München

Not only building and industrial insulation actively contribute to a sustainable climate protection but also and in particular every single one of us. For a few years now, FIW München has maintained a biking list throughout the entire institute in which the employees can document the kilometers they biked to work. The concept of having a little competition as to how often and how much one has cycled provides an additional incentive. However, the motivation is not only based on the competitive aspect but also on the objective of collecting as many kilometers as possible together and saving CO2 with one's own muscle power. Another favorable side effect is the reduction in health problems and in the stress caused by the high traffic load in Munich.

In 2017, FIW München had a very successful biking year, with 37,384 kilometers biked in total (which corresponds to 4.9 tons of CO2 savings). To actively support this commitment, the management of the institute decided to donate one Euro for every ten kilometers cycled to Zentrum Umwelt und Kultur (ZUK) [environmental and cultural center] at Benediktbeuern monastery. In the end, this sum was rounded to € 3,750. The Zentrum für Umwelt und Kultur was founded in 1988 by the Salesians of Don Bosco and actively promotes the concept of responsibility for creation. Specific educational and cultural programs aim at promoting the appreciation and the dedication for the diversity of life in children, teenagers and adults. Particular attention and praise is paid to the project "Hoffnungsstark – Umweltbildung gegen die Ausgrenzung Jugendlicher" [strong hope – environmental education against the social exclusion of teenagers] for disadvantaged and behaviorally challenged children and teenagers. FIW München is pleased to be able to support this project.

Thus, FIW München contributes both individually but also as a community to a healthier way of life, sustainable environmental protection and a better future.

Zentrum für Umwelt und Kultur Benediktbeuern

Image 1 Berger, Wiesemeyer, Basel, Hofmockel, Regauer, Moosburger, Timmermanns, Jahn, Klasche, Kutschera, Coy, Gurewitsch - nicht im Bild Kuttner, Guess, Bernthaler, Tana, Cziglar, Kümmel, Glöß, Sprengard, Hirmer, Zehentner, Schneider, Hupfauer, Kagerer

Impressum

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