Be sure. testo

Practical guide thermography for building contractors.

Introduction.

Climate change and the growing demand for energy, when at the same time fossil energy sources are getting ever scarcer, represent one of the greatest global challenges. Because a relevant proportion of emissions involve the building sector, special efforts are needed in this area to achieve the internationally agreed climate objectives.

A large part of heating energy is lost through poorly insulated walls, roofs and windows. Effective insulation therefore not only saves costs, but also protects the environment through lower CO_2 emissions. Thermography has developed as a method for checking the actual condition of buildings and the potential for energy savings. Both hidden weak spots and implementation defects can be detected non-destructively and their causes determined.

Content.

Potential energy savings:
Stimuli for the building industry, house owners and the climate.

While attention is now being paid to energy-efficient construction methods for new builds, existing buildings have a long way to go to catch up in terms of their energy consumption: here it remains essential to discover major potential energy savings through refurbishment and modernization. The improvement of the energy standard of their building, for instance through heat insulation or the installation of new windows, also represents a relevant cost saving for both house owners and tenants. Both in the run-up to an energy-based refurbishment, for instance for the identification of thermal bridges and other building defects, and when checking the measures implemented, thermography plays an important role nowadays.

Thermography as an efficient measuring instrument for the construction sector.

Thermography is a non-destructive testing and measurement method based on infrared radiation which is invisible to human beings. It has become firmly established in the construction industry, because it enables conclusions to be drawn about heat insulation and possible structural defects, such as thermal bridges, using meaningful thermograms. It can be deployed as both indoor and outdoor thermography and offers a wide range of possible applications:

- Structural design:
  new builds, building refurbishment, monument preservation and quality control
- Energy consulting
- Technical building services, including fire protection

Building thermography is relevant for the following interest groups, amongst others:

- Housing companies, structural designers, architects, installation companies, building experts, workshops
- Purchasers, owners and tenants

Methods and fields of application.

In general, thermography of the external building shell is possible, as well as in the interior. The definition of a thermographic measurement task, the building design and the environmental conditions ultimately influence the choice of method. With ventilated façades and roofs, measurement is generally carried out from inside, with the detection of intermittent energy losses arising from convection heat due to insulation defects also being possible from outside. With other façades, including for example half-timbered houses, thermography of both the external shell and the inside is normally carried out.

Thermography of the external building shell

Outdoor thermography enables a fast energy assessment of the whole building shell. It provides an overview of the heat released by the outer wall and is therefore predominantly used for locating weak spots, such as

- thermal bridges,
- leaks,
- insulation defects and
- moisture damage in the building shell.

However, the circumstances in terms of perspective mean that outdoor thermography can only be used to a limited extent for checking roofs. As a rule, thermography of the external building shell is only employed for the preliminary image-based representation of temperature distributions and of the consequences that may arise from these. An indoor measurement is also carried out to obtain meaningful measurement results.

The areas of application for outdoor thermography include:

Locating thermal bridges

Thermal bridges are among the heat-related building defects that occur most frequently. Thermal bridges are deemed to be localized areas through which heat is more rapidly transported to the outside than through the other components. They

Visualizing energy losses

firstly cause a great deal of energy loss and secondly condensation, which may in the end lead to mould formation. Thermal bridges frequently occur on

- balconies,
- window frames and lintels,
- hollow ceilings made of reinforced concrete and
- non-insulated components.

Locating hidden structural features in new builds, old buildings and historic buildings

Outdoor thermography provides a quick method for detecting possible structural defects. It also enables the identification of timber frames coated with mineral plaster. The infrared

image also reveals areas where plaster is breaking off. Thermography is ideally carried out around two hours after sunset.

Investigating water damage

Outdoor thermography can give useful indications about the cause or impact of water damage.

Indoor thermography

Indoor thermography involves thermal images being taken of the interior of a building or of components. The advantage of this process is that the same temperature prevails over a longer period of time indoors and also that the external influences of the weather require only limited consideration. Indoor thermography can for example enable

- insulation damage,
- leaks in pipe insulation and
- underfloor heating pipes

to be visualized in a targeted way. At the same time, the method also supports locating the causes of

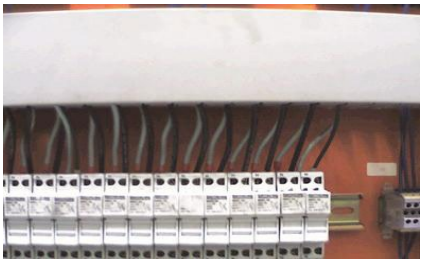
- moisture damage or
- mould formation. Many thermal

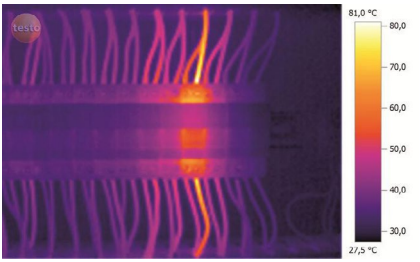
weak spots can only be detected using indoor thermography. In addition, other measurements, such as the differential pressure measurement method (also: blower door test), are substantiated by indoor thermography. Indoor thermography is used in a much broader range of areas of expertise:

Visualizing temperature differences

For ventilated façades and roofs

Ventilated façades and roof extensions can only be examined for their insulating effect and air tightness from the inside, except where there is convection heat: in this case, it is also possible to see spots that are thermally conspicuous from the outside. Targeted location of the defect on the outside is not possible, because heat losses are released directly into the air which flows over the component.





Defect in the switching cabinet

Locating air permeability using the blower door method

Thermography is often used in combination with blower door measurement to check for air permeability. The process involves building up a pressure difference of around 50 Pascals (Pa) between the surrounding area and the interior of the building. There is an ingress of cold air where there are leaks. The temperature differences between outdoors and indoors should be at least 5 °C (K). The temperature difference is displayed using the thermal imager. This means defects can be located at an early stage and necessary insulation measures introduced accordingly.

Technical building services, including fire prevention

Indoor thermography can also be used for checking ignition hazards in the vicinity of firing installations and flue gas systems. This also includes the functional testing of heat distribution for panel heating systems. With insulated steam or heating pipes, there is often a potential hazard due to weak spots in the insulation or at brackets which transfer heat. Thermography is also used for testing electronic systems in the low voltage range, such as switch boxes. Even cables, contact points or cable runs which have high temperatures and are difficult to see can be located in this way. Lines with PVC insulation must not be hotter than 70 °C, or 40 °C above the temperature in normal conditions; the guideline values of 100 °C or 60 °C apply for copper terminals.

Investigation and location of pipes

Thermography is also used for the location and testing of pipelines (e.g. detecting a build-up of slag in radiators) as well as leaks in heating pipes, even when the pipes are laid in the floor or under plaster.

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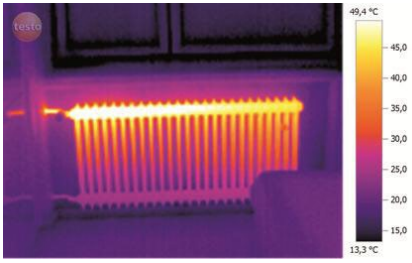
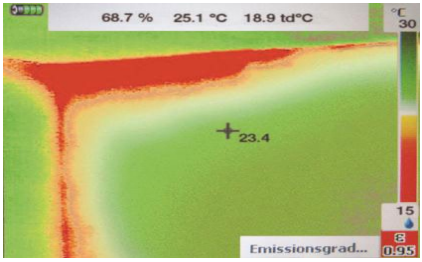
Detection of moisture damage

Thermography enables easy and non-destructive detection of moisture damage. Thermal bridges, structural damage and incorrect ventilation behaviour can lead to moisture condensation from the ambient air – this may result in mildew or mould formation.

Leak detection



Inspection of a radiator



Mould detection

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Conditions and requirements.

Conditions for outdoor thermography.

For a thermographic inspection of the outer building shell, the following prerequisites have to be met:

- The weather must be dry and temperatures low to allow outdoor thermography to be carried out properly.
- The building shell must not be wet due to precipitation – it is not possible to carry out outdoor thermography when there is rain, snow or thick mist.
- The wind speed should be below 5 m/s (18 km/h).
- The pre-condition is a temperature difference of at least 10 to 15 °C between indoors and outdoors over a period of at least 12 hours.
- For this reason, the inspection generally takes place in cold seasons in the morning before sunrise – sunshine influences on outer surface, even in the previous hours, falsify the results.
- An exception to this is for instance thermography involving cold stores, which means the same required temperature difference applies, but it is the other way round here, and the measurement should therefore be carried out in warm seasons.
- A further exception is thermography on timber-framed buildings. This is normally carried out in the summer semester, because the different warming or cooling process of the materials is exploited here. In this area, thermography is ideally carried out two hours after sunset.
- The areas being investigated must be clearly visible – interfering radiation from other objects (e.g. neighbouring buildings) must be taken into account.
- Depending on the lens used, a camera distance of around 15 metres from the building is required for complete external imaging of the side of a house, when this involves single family homes. For apartment buildings, a considerably greater distance is needed, depending on their size – if that is not possible, several images must be taken to complete the task.

Conditions for indoor thermography.

Specific requirements also have to be met in terms of measurement in order to carry out meaningful indoor thermography:

- In contrast to outdoor thermography, indoor thermography is possible all day long.
- Indoor areas should be heated for 12 hours in advance to at least 20 °C – the temperature in the building should be as constant as possible, which can for instance be achieved by opening doors.
- All windows should be kept closed.
- The heating must be turned off around 1 hour before the measurement.
- Furniture, coverings and curtains should be moved away from walls or taken down 12 hours before the measurement.
- In certain circumstances, it makes sense to use other measurement and investigation methods, such as the blower door test, when testing air tightness.
- Detection on heating pipes should preferably be carried out in the phase when the system is being switched on or heating up. It is absolutely essential here for you to wait until the pipes' return flow can be seen – this may take some time.

Summary.

Building thermography is a measurement method which enables non-contact and non-destructive recording of surface temperature distribution and allows the assessment of thermal characteristics. Building thermography can be used in many areas. It offers a fast method for detecting structural defects, such as thermal bridges and air permeability, but also faulty pipes and leaks, and for documenting them unequivocally. Furthermore, it is an effective tool in terms of energy cost saving. Health-related aspects and fire prevention are also strong arguments in favour of the use of thermal imagers.
However, because many thermal weak spots can only be seen from the inside, it is generally necessary to carry out both outdoor and indoor thermography. To supplement measurements, thermographic inspections are also often carried out in combination with a blower door test. However, when the thermographic measurement is performed, factors such as the weather, indoor climate inside the building and measuring distances must also be taken into account.

Advantages of an investment.

Although purchasing a thermal imager represents a significant initial investment, there are numerous arguments and a lot of evidence showing that this investment will soon pay off:

- Thermal imaging significantly reduces the time taken to locate a leak or find a fault on an underfloor heating installation or heating system pipework.
- Once located, both you and your customers will benefit from less cost and disruption due to a clear reduction in the need for unnecessary excavation work.
- Utilising thermal imaging technology to increase efficiency will enable you to accommodate additional customer visits.

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Technical features of thermal imagers.

When choosing a thermal imager that is suitable for a variety of applications in the building industry, you will need to take a number of criteria into consideration:

- Infrared resolution/number of pixels
- Thermal sensitivity
- Image display
- Field of view
- Software
- Camera functions: scaling adjustment by manual level and span setting
- Easy to use
- Product support

All of the above parameters are of key importance. In applications such as tracing heating system pipework and searching for leaks, temperature differences can often be quite small, and it is therefore absolutely essential to select a suitable thermal imager that will deliver useful results.

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Infrared resolution / number of pixels

The infrared resolution / number of pixels determines the image quality, and the main consideration here is that the thermal image should be of sufficient resolution or quality to ensure that the required details can be seen clearly. The higher the infrared resolution, the better it will be able to resolve details. The minimum resolution for these types of application is 160 x 120 pixels (19,200 pixels), a resolution of 320 x 240 (76,800 pixels) is recommended.

Thermal sensitivity

High thermal sensitivity is an essential requirement for thermal imagers which are intended for use in building thermography. The aim is often to detect small temperature differences, such as when attempting to locate heating system pipework and leaks. The term “thermal sensitivity” is used to describe the size of the temperature differences which a camera can detect. The better the thermal sensitivity, the smaller the minimum temperature difference that the thermal imager is able to detect and visualize. Thermal sensitivity is usually described in °C or mK. Thermal imagers for applications in heating engineering, particularly for locating pipework and leaks under floors, must have a thermal sensitivity of at least 0.1 °C (100 mK).

Image display

It is essential for thermal imagers to have a large display. This is the only way to clearly indicate any problems straight away. The bigger the display, the more of the defined task will be visible. A 3.5 inch display is a must-have in order to get a satisfactory overview. You can then take the appropriate actions and immediately begin problem-solving.

Field of view

For many HVAC applications in buildings, a wide field of view is a key requirement. When locating heating pipework or inspecting underfloor heating systems, you often have to view and inspect large floor areas. A wide field of view is also necessary in order to get a full view of radiators or sections of ceilings. There is often insufficient room to be able to take a step back, which means you can only see large sections of an object with a wide field of view.

The testo 871s and testo 872s thermal imagers are fitted with a standard lens that has a large field of view as standard. The smaller the field of view, the further away from the subject it is necessary to position yourself, and the further away you are, the less detail is visible.

Camera functions: scaling adjustment by manual level and span setting.

One of the most important features of a thermal imager is the ability to manually adjust the scaling. This is achieved by setting the level and span to provide the optimum contrast for the thermal image, so that small temperature differences can also be highlighted. Simply using the camera in Auto Mode may potentially result in areas of small temperature differences being missed, or not displayed in sufficient contrast to make them visible. When tracing heating system pipework and locating leaks, checking underfloor heating or detecting concealed flue gas pipes, the scaling often has to be minimized. This allows the detection of small temperature differences relevant in these types of application.

The testo 871s and testo 872s cameras also have the testo ScaleAssist function, which automatically ensures optimum setting of the thermal image scale. This simplifies the detection of thermal bridges and prevents incorrect interpretations, because unwanted extreme temperatures are filtered out. This also enables the reliable comparison of before and after images.

Software

The reporting software enables optimization and analysis of the images and also ensures that the findings in the images can be clearly presented and reported. The software needs to be easy and intuitive to use, with a clear structure and high degree of user friendliness. It should also support quick and easy reporting.

Ease of use

The camera must be easy to operate safely. Important features are intuitive operation, user-friendliness and flexibility through suitability for a variety of applications.

Product support

When purchasing a thermal imager, it is important to ensure that you select a camera that best suits your application needs and requirements. Therefore, you need a reliable supplier with the technical capability and specialist knowledge to provide the support required to help you with your selection.

Thermal imagers
testo 871s, testo 872s and testo 883.

The easy operation and informative, high-resolution images of the testo 871s, testo 872s, and testo 883 thermal imagers mean they are ideal for the reliable and precise detection and visualization of structural defects in buildings. The thermal imagers are also suitable for the thermal inspection of materials and components in the industrial sector.

These features are characteristic of all models:

- Large, high-resolution 3.5 inch display
- High thermal sensitivity
- Up to 2,000 images can be saved
- Automatic hot-cold spot recognition
- High-performance analysis software
- Two-year warranty

testo 871s

- Infrared resolution 240 x 180 pixels
- testo SuperResolution for 480 x 360 pixels in the camera and App
- Thermal sensitivity <0.08 °C (80 mK)
- FixFocus standard lens 35°
- Integrated digital camera
- Free testo Thermography App
- Bluetooth connection to optionally available thermohygrometer

testo 872s

- Infrared resolution 320 x 240 pixels
- testo SuperResolution for 640 x 480 pixels in the camera and App
- Thermal sensitivity <0.05 °C (50 mK)
- FixFocus standard lens 42°
- Free testo Thermography App
- Bluetooth connection to optionally available thermohygrometer

testo 883

- Infrared resolution 320 x 240 pixels
- testo SuperResolution technology 640 × 480 pixels
- Thermal sensitivity: <0.04 °C (40 mK)
- Manually operated standard lens 30°
- Optional telephoto lens 12°
- Free testo Thermography App
- Bluetooth connection to optionally available thermohygrometer

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Testo – the company.

Testo, whose headquarters are in Titisee in the Black Forest, is an expert for innovative measurement solutions.

The products: measurement solutions for demanding target groups

What do the storage of drugs, quality assurance in the food sector or the optimization of ambient conditions in an industrial building have in common? They can all be achieved easily, reliably and efficiently, thanks to measurement solutions from Testo. Our products help to save time and resources, to protect the environment and humans, and to increase the value of goods and services.

The history: a success story since 1957

Through a strategy of sustainable and profitable growth, the small Black Forest temperature measuring instrument manufacturer, Testo, has developed into a global group with 36 subsidiaries and more than 80 sales partners. Over 3400 committed employees research, develop, produce and market for the company with passion and expertise all over the world.

The perspectives: onwards with strength from within

The above-average investments in the future of the company are part of the recipe for success. Testo invests approximately a tenth of the annual global turnover in research & development, consolidating its position as a leading specialist in the field of portable and stationary measurement solutions. In order to maintain this leading position, Testo places great value on training young people and ensuring the next generation of experts and management staff, for example with a classical apprenticeship, the tailor-made post-Master professional entry program VIA, or numerous qualified further training programs.

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