Infrared Technology
StructureScan™

The Scientific Process

Wet insulation in a roof system should never be ignored. It can cause leakage, structural damage, and even health hazards. Thermal imaging (infrared) of the roof is generally agreed upon by experts as being the most reliable method for detecting moisture, but to successfully utilize this method, it is important to understand the scientific aspects involved and the technology of infrared cameras.

Heat

The first aspect of the whole equation is heat. Heat is the energy an object has because of the motion of its molecules,

which are constantly in motion. When energy is added to an object, its molecules move faster, creating more heat.

There are three ways heat is transferred. The first is through conduction, the flow of heat energy through solid objects–either from one part of an object to another or between objects which are touching. Convection, the second method, is the transfer of heat through the movement of liquid or gas such as water or air. The third method is radiation. We tend to associate this word with "bad radiation." However, radiation, as it pertains to heat, is merely the transfer of heat energy which consists of electromagnetic waves that are emitted in all directions without the need of a solid or fluid to transfer. It sounds complex, but really this is the heat you feel from the sun or standing next to a campfire.

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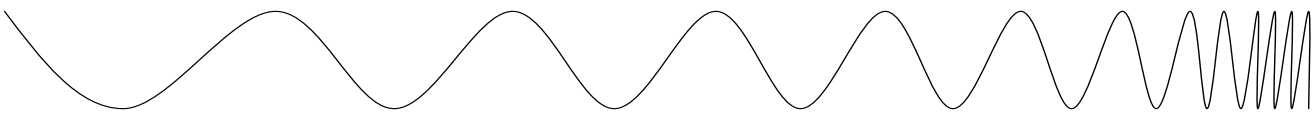
Electromagnetic Spectrum

This heat, which our skin can feel but our eyes don't see, is a part of the ES (Electromagnetic Spectrum).

When you look at the world, you see colors. Colors are visible light waves (or visible radiation). Our eyes, however, can only see a very small portion of the light waves (radiation) which make up the ES. The ES includes gamma rays, x-rays, ultraviolet, visible, infrared, microwaves, and radio waves.

All radiation, or light, in the ES is made up of vibrating waves of electrical and magnetic fields. These waves have different wavelengths, energies, and frequencies. Basically, the longer the wave, the lower the frequency. Gamma rays are the shortest and most frequent, while radio waves are the longest and least frequent. All waves are usually described by their wavelengths in units of micrometers or microns (one millionth of a meter).

The Electromagnetic Spectrum and Infrared Technology



Radio | **Microwave** | **Infrared** | **Visible** | **Ultraviolet** | **X-ray** | **Gamma Ray**

Longwave Camera Technology
Built-up Roofing
Modified Bituminous Roofing
(rest of) Single-Ply Roofing

Shortwave Camera Technology
Ballasted Roof Systems
White Membranes
Reflective Coatings

NOTE: Various technologies are **essential** for different roof assemblies. With varying degrees of sensitivity, different cameras are required for different applications. Knowing and understanding the intricacies of **infrared and roofing technology** is essential for proper roof evaluation.

StructureTec® / Tec Data

Infrared (meaning far red) is the name given to the part of the ES that occurs just beyond the red end of the visible spectrum.

All objects have heat and omit infrared radiation unless they have a temperature of absolute zero (-273 C).

All forms of radiation travel through space in a similar fashion to visible light. Infrared radiation is simply a form of light which requires a different filter to be seen. This light can give information on how much heat objects have.

Our eyes are the detectors which determine the color an object has. An infrared camera is a detector to determine the heat an object has.

Thermal Imagers or Infrared Cameras

Infrared Cameras allow the viewer to see heat and how it is distributed. It presents a pictorial representation of temperature differences.

Because infrared radiation behaves like visible light, it can be optically focused and collected by the detector and lens combinations in an infrared camera. The lens focuses the waves from infrared energy onto a sensor which converts them into electrical signals which are created into a visual image. This technology relies on contrast to generate the image. Usually, shades of gray are used to show discernible temperature levels. These images can be video or still, depending on the camera. It is crucial to remember that the results are usually qualitative rather than quantitative, meaning you can see temperature differences but not the exact temperature measurements.

Roofing & Infrared Technology

Moisture in a roof system is a serious problem for facility managers. One major problem, however, is that unless there is a visible opening or a leak inside the building, visually examining a roof will not determine if there is moisture within the roof system and insulation. Thermal imagery and infrared cameras, however, can provide a way to see whether there is moisture in your roof system.

Moisture (water) is an excellent conductor of heat. When insulation in a roof system is damp, that insulation becomes a conductor rather than an insulator. This situation is actually much worse than having no insulation. The expense to heat or cool a building will be greatly increased as the wet insulation allows free passage of energy in and out of the building.

Solar energy plays an important role in detecting the moisture in a roof system. In a dry roof, solar energy hits the roof and is absorbed and then reradiated (emitted) back into the atmosphere. The dry insulation prevents that energy from entering the building. In a wet roof, solar energy hits the roof and is absorbed through, allowing energy to be conducted into the roof system and the building. At night, after the sun has set, the dry roof will appear cool because the energy it received was radiated back into the atmosphere rather than conducted and stored. The wet roof, however, will appear warmer as it finally radiates all of the energy it has been conducting during the day. This is why the best thermal contrasts usually occur several hours after sunset.

There are two main types of infrared cameras used to examine roof systems. The first measures **longwave** infrared. This type of camera can be used on the majority of flat roofs. Ballasted roofs, however, usually require the use of a **shortwave** infrared camera. The rocks on this roof system make thermal imagery a challenge. Besides the use of a shortwave camera, intense solar energy is usually required for an accurate, clear image to be recorded. White/reflective roofs also require the use of a **shortwave** infrared camera.

It is also important to consider emissivity. Emissivity is a measure of the amount of energy an object absorbs and reradiates (emits) versus how much energy it reflects. A white object or a shiny object will reflect much more energy than a dark object does. The emissivity of different objects varies greatly, which means that two objects may appear differently while still having the same temperature.

Using Thermal Imagery

It is important to remember that the process is extremely scientific, the equipment is exceedingly sensitive, and the results are qualitative rather than quantitative. All of these factors require that a qualified, knowledgeable, and experienced operator needs to perform the scan and process the information in order to accurately determine the correct results.

In conclusion, if used correctly, there are many benefits with using thermal infrared imagery to evaluate roofing systems. The method does not require direct contact with the roof but rather pictures are taken of 100% of the roof surface. This allows for a relatively quick inspection. This also enables a precise picture of the roof to be viewed. The results are shown visually and are also normally mapped out on the roof surface. This process ensures that accurate repairs can be made on the roof system to remove the areas of wet insulation, therefore maximizing the service life of the roof system.