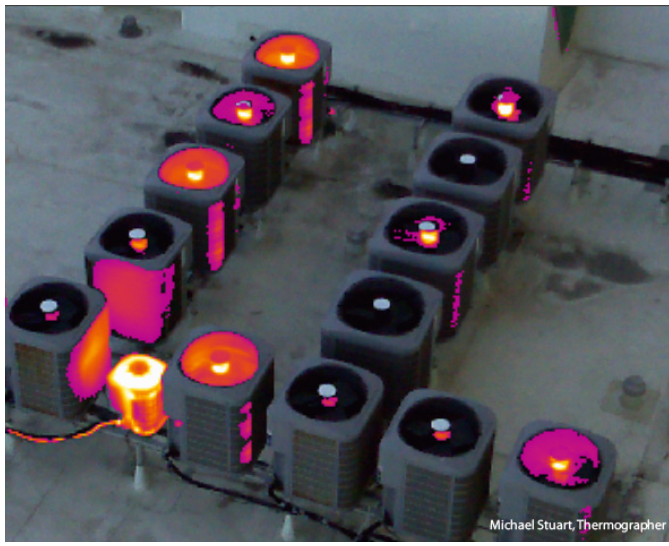
APPLICATION NOTE

How to improve your HVAC-R system with thermography

Human beings are the only species that actively tries to manipulate their environment on a regular basis. If it is cold outside, we seek the warmth of going indoors. If it is hot outside, we want to hide indoors with the air conditioner on full blast. At the end of the day, we seek environmental comfort, so we design and manufacture special machines to accomplish these temperature-centric tasks.

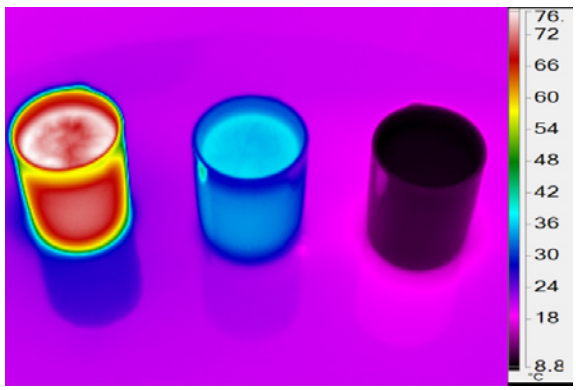


It is the job of the HVAC/R (heating, ventilation, air conditioning, and refrigeration) professional to properly install, maintain and service these valuable machines. At its core, HVAC/R is all about the movement of heat or cold from one place to another. Therefore, thermal imagers are ideal tools for assisting the HVAC/R professional, as they help us "see" the effects of heat movement in important components.

What is thermal imaging?

Thermal imaging is the science of showing the surface temperature of all objects, by utilizing electronic cameras which are capable of capturing radiant heat emitted from any object. In the example to the right, the visible image shows that all three mugs have liquid (water) in them. By using a thermal imaging camera, we are given additional visual information, as we are able to see that the surface temperature of the water in each mug is different. The color palette on the right shows the colors for the different temperatures. For this particular color palette, the hottest temperature is shown white and the coldest temperatures as black.

Visible light image



Thermal image (temperature color palette on the right)

What are the applications in HVAC/R systems?

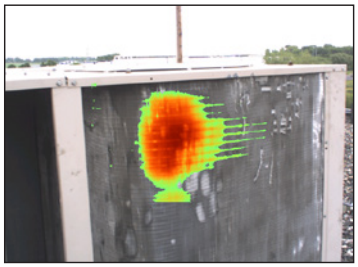
HVAC/R equipment is an electro-mechanical system. Both electrical and mechanical parts of the system can lead to the loss of electrical or mechanical power throughout the system. This power loss manifests itself as heat energy, and/or vibration.

In an electrical system, heat loss due to a loose connection leads to the resistance of that connection increasing, resulting in more power dissipation at that point. If this is left undetected and unresolved, the cycle of increasing resistance and power dissipation can end in failure, with potentially catastrophic and expensive results. In a mechanical system, if the heat loss is due to misalignment or wear, the increased power loss will exacerbate the issue, again leading to a vicious cycle of eventual failure.

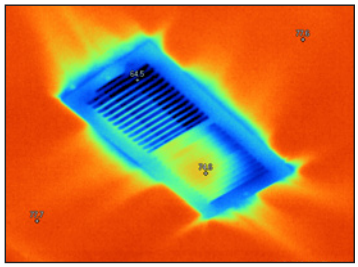
A thermal imager can be used to identify heat losses in both types of systems, which would allow for you to correct the fault. This approach is usually part of a preventive and predictive maintenance routine. It is common for these HVAC/R components to be inspected with a thermal imager during rounds:

- Air conditioning and heating unit inspection (commercial and residential)
- Chiller inspection
- Duct work inspection
- Furnace inspection
- Motors, pumps, fans, blowers
- In-floor heating systems (hydronic and electric)
- Refrigeration and freezer systems
- Heat exchangers

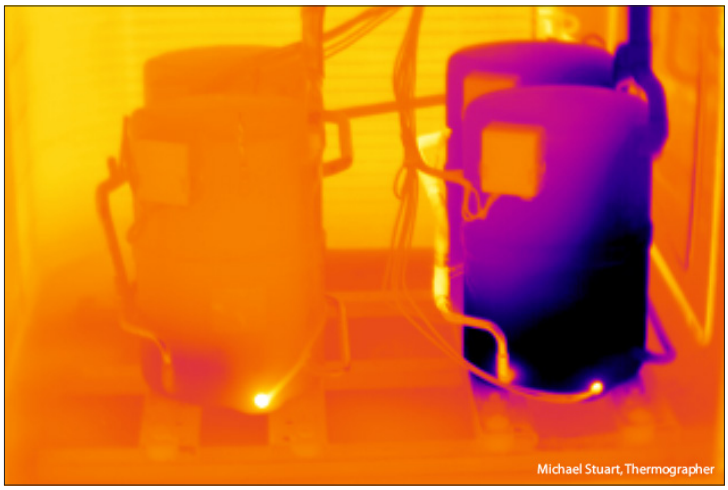
Examples of thermal images and possible issues



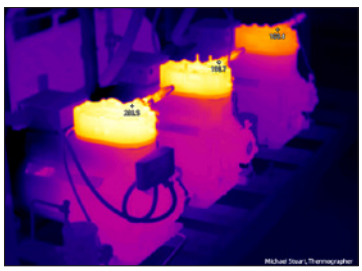
Area of clogged cooling fins impeding proper air flow into the unit.



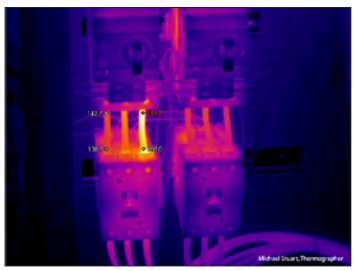
AC unit. One side (lower) not working as efficiently as the other.



Second-stage compressors not coming online at proper time.



Back rooftop compressor tripping and not operating on proper cycle times.



High resistance connection.

Typical reasons for temperature hotspots or deviations

- Bad cooling due to reduced airflow
- Power quality problems like unbalance, overload or 5th harmonic (voltage) will cause heat dissipation
- Bad alignment
- Insulation problems with motor windings
- Bearing problems
  - Under lubrication or over lubrication
  - Coupling misalignment
  - Drive belt problems
  - Misalignment
  - Too tight
  - Too loose
  - Wear

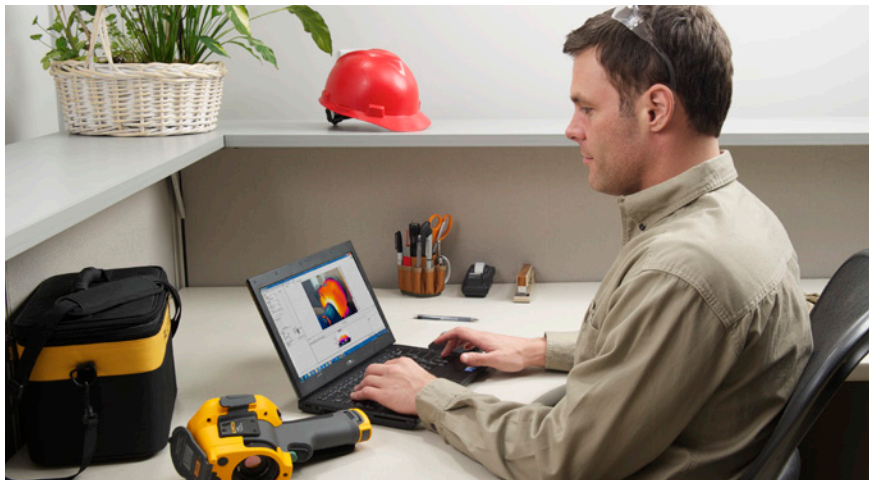
History of thermal imagers in preventive maintenance

In the 1960s, military units throughout the world were prepared to spend $100,000-plus for a single heat-seeking camera. Over the next 40 years, advances in technology introduced thermography to a wide variety of new markets where costs had previously been prohibitive.

By the 1990s thermal image camera prices were typically in the region of $20,000 to $50,000, allowing professionals who could justify the cost. This then formed a community of thermography consultants. These consultants generally worked for larger companies, who identified the benefits of thermography data. However, the cost of the cameras outweighed their everyday usage for most companies.

At the turn of the century, prices dropped to around $10,000. While this is significantly lower than previous, this price was still too steep for many potential users. Subsequent price drops—with thermal imagers now available for below $1000—made the technology more attainable for the industry sectors where the cost could not previously be justified, as well as others who were unaware of thermal imaging technology's benefits.

Most facility managers and their teams, as well as large to mid-sized contractors, now own thermal imaging cameras. As the cost of lower resolution cameras is within hundreds of dollars, the technology likewise fits better into their budgets.



9 benefits of thermal imaging

Thermal imaging applies to many diverse industries. This technology can have a great impact on how we take measurements and, therefore, how companies approach preventive maintenance. Thermal imagers:

1. Are non-contact, so technicians can inspect from a safe distance, especially when there is a live load or high voltages present
2. Do not require any disturbance to production—on the contrary the equipment needs to be at a 40 % load for a quality inspection
3. Are very sensitive to problem characteristics, which lets you detect small temperature differences
4. Detect problems before significant damage occurs (potentially saving your company or customer a lot of money), a cornerstone of predictive maintenance
5. Let you scan large areas quickly (it works like a normal video camera)
6. Save valuable time by quickly identifying specific locations where latent faults might be
7. Reduce frustration, since you can find individual faults using heat as an indicator, without wasting time getting to the root cause
8. Help save money, as detecting problems before damage occurs improves your team's uptime
9. Help make money, as contractors can walk into a site and simply impress their clients by using the right tools for the job

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