INFRARED 101

How Does It Work and Will It Make You Money?

Marty Sawyer
Trimac Industrial Systems
The Science of Heat
What is heat?

*The simple answer... heat = energy*

Thermal energy (heat) can change the matter it touches. It makes molecules move and can also cause chemical reactions like burning to occur.
How is heat transferred?

CONDUCTION – heat transferred by direct contact to solid matter

CONVECTION – heat transferred through movement of a fluid (gas or liquid)

RADIATION – heat transferred by electromagnetic waves
How does matter get hot?

Thermal Energy causes molecules to move and always from hotter to colder. When all matter is the same temperature, thermal transfer stops and you have thermal equilibrium.
And infrared can make things hotter?

*Infrared energy is how the sun heats the earth*
What is Infrared?

Electromagnetic waves of light energy
How is infrared heat generated?

ELECTRICAL GRID

CHEMICAL REACTION
How does Convection heat parts?

When air molecules are heated, they expand and become lighter. The heated air then rises. As it rises, it cools causing it become more dense and then fall again.

This exchange movement of heated expanded air vs. cooler dense air is what creates a natural convection airflow.

A convection oven adds forced heated air flow to magnify this effect and heat the parts.
How does Infrared heat parts?

Some heat is reflected away as light, depending on the colour of the material surface.

Direct Solar Gains

Absorption increases surface temperature

Some heat is conducted deep into the material
Types of Heat
Convection

Gas or Electric

250º - 500º
Convection

• Pros:
  • Easy to operate
  • Very flexible
  • Industry standard

• Cons:
  • Cost to operate
  • Slowest
  • Inconsistent heat
  • Environmental impact
  • Lowest quality of finish
  • Takes most amount of space
Gas Catalytic Infrared

*Gas Long to Medium Wave*

250º - 1,000º
Gas Catalytic Infrared
(medium to longwave)

• Pros:
  • Lowest cost to operate
  • Speed of cure
  • Can cure a complex part
  • Environmental
  • Well absorbed by part
  • Suitable for Explosion Risk Installations
  • Consumes VOCs as fuel

• Cons:
  • Won’t suit every part
  • Learning curve
  • Can be highest first cost – approx. 10%
Electric Infrared

Electric Medium to Short Wave

850º – 4,200º
Electric Infrared
(short to medium wave)

• Pros:
  • Fastest heating technology
  • Immediate to instantaneous reaction
  • Uniformity of heat
  • Environmental

• Cons:
  • Highest operating cost per BTU
  • Can be unforgiving
  • Learning curve
Does IR wavelength matter?

Depends... what is your part, profile and process?

- Wavelength = temperature
- Higher temperatures = more power & speed
- More power & speed = less flexibility
- Absorption better at lower temperatures. Power better at higher temperatures.
Infrared Controllability

• Zoning – top to bottom &/or front to back
  • Convection has one temperature for the oven. Through the use of infrared, you can zone the oven to achieve differing heat profiles
  • All infrared has the capability potential control the heat down to individual heaters

• Temperature levels
  • Convection typically has a low fire ability to modulate temperatures when oven not in full use. No other temperature controls available
  • All infrared has significant turn-downs available to moderate temperature profiles as the mix changes
Heat Uniformity

• Convection
  • Typical is 10 deg + or – across oven

• Infrared
  • Depending on heater design can have up almost 100% uniformity across heated profile
Why use Convection vs IR

• Easy to operate
• Can heat basically any part
• Industry Standard
• Can accommodate dual lanes
Why Use IR vs Convection

- Control of heat
- Uniformity of heat
- Operating cost savings
- Space savings
- Faster production
- Work in process savings
- Environmental benefits
- Quality
The Proof
See the Cure

PART ENTERING IR OVEN

Powder gels at lightest purple

Cure begins at orange

35 second timespan
Catalytic Infrared vs. Convection

Side by Side Test
Catalytic Infrared Oven
Convection Oven
Test Results

Catalytic Infrared vs. Convection

00:06:45 Catalytic Infrared
00:30:00 Convection

Cure time comparison
Target temp = 325°
Environmental Impact
Real World Applications
What type of heat to use when?

3 P’s of infrared

• Part
• Profile
• Process
Best applications for Convection

• Want maximum flexibility in types of parts processed
• Uniformity of heat is not critical
• Very complex part configurations
• Want to mix and match parts on same line
• Sufficient available space
• Want proven, easy to purchase technology
• Have dual lane conveyor system
Best applications for Catalytic Infrared

• Cost to operate is driving force
• Want speed of infrared, but still need flexibility
• Softer heat is needed
• Wet paint applications
• Hazardous location concern – can be classified Class 1, Div 1
• Want to reduce Time on the Line
• Space is at a premium
Best applications for Electric Infrared

- Substrates requiring very tight heat control
- Speed of heat transfer most important feature
- Preheating large parts
- Boosting large parts
- Gaps in line
- Very fast line speeds (20+ feet/min)
- Want to reduce Time on the Line
- Space is at a premium
Infrared efficiency

• Medium wave Electric Infrared has the highest efficiency ratio of converting electricity into infrared heat

• The high temperatures along with the efficiency is why electric infrared can perform work the quickest of all heat technologies

• This also is why controls in electric infrared are so critical as it is easy to overheat parts

• Catalytic infrared has a lower temperature and efficiency and also produces convection heat which is why it is slower than electric but can cure complex parts
Energy gained / energy used
Speed / cost

Infrared Efficiency
Speed / cost

Infrared Efficiency

- Operating costs
- 1\textsuperscript{st} costs
- Cost / sq ft
- Control
- Time on the Line
How to choose a heat type

- Response time needed
- Heat sensitivity of part
- Line speed
- Utilities available
- 1st cost
- Operating costs
- 3P’s
Specific things to consider...

• How precise must the control of heat be?
• How variable are the parts?
• How important is heat uniformity?
• Will there be many gaps in the production process?
• Do the parts have a complex shape?
• How important is time on the line?
• How important are operating costs?
• Is flexibility a driving factor?
Buying recommendations

• If decided on convection, many quality suppliers exist in the marketplace.

• Infrared ovens are typically designed for a specific application, while convection will be much more standardized.

• Always work with a reputable supplier who has extensive experience as designing infrared applications can be complex.

• If considering infrared, always ask for a test. Different parts, different materials, different coatings can all create different results. Select a manufacturer who can design for the full compliment of your parts.
Infrared will typically be a minimum of twice as fast and can be up to 10x times faster than convection depending on application.

• Electric will be the fastest to heat a part
• Catalytic will be a little slower
• Convection will be substantially slower
Summary

• Convection is best when maximum flexibility is desired

• Infrared is best when control, speed, time on the line, operating costs or space are primary factors

• What is the best heating technology??? IT DEPENDS…

• There are no bad technologies, just bad applications
www.infra-red.com

it’s a heat wave

Marty Sawyer

TRIMAC INDUSTRIAL SYSTEMS, LLC
msawyer@trimacsystems.com
(800) 830-5112