Heraeus

# A comparison of Convection vs. Infrared

## How is heat transfer different?

Convection can only be controlled by air temperature and airspeed.

With infrared emitters a far greater flexibility in heat up rates and temperatures can be achieved using different energy densities and wavelengths.

## How energy efficient are the technologies?

Convection can waste a lot of energy when switching from large to small components,

Infrared emitters can target energy to areas that require heating.

## How long are the reaction times of the heating systems?

It may take 30 minutes to 2 hours depending on the size of the convection oven, so an oven will be left running all-day even when there is no production.

Infrared emitters can be switched on and off within seconds to suit production conditions.

## How is the influence of mass change?

In convection oven the heat up rates will be influenced by mass (number) of components.

Infrared is an "energy source" and is not influenced by the number of components in the oven.

## How much space is required?

Convection takes up a large amount of floor space.

Infrared is a lot more compact, typically 1/4 to 1/3 the space

## What about maintenance costs?

Convection requires frequent maintenance (fans, filters, pipes, seals, burners) and full maintenance normally makes necessary a complete strip down of the oven.

Infrared systems normally only need low maintenance like a changing of emitters or filters.

## How do you control temperature with changing parameters?

For convection ovens it takes a long time to reduce or raise the air temperature to suit changing line conditions.

Infrared emitters can be regulated instantly to changing conditions; a closed loop control via speed or temperature is possible.

## Is it possible to cure/dry large conductive components like engine blocks?

A slow rate of heat transfer from air allows heat to conduct into components leading to long heat up times.

Using infrared emitters with a high transfer of energy enables surfaces to be heated more rapidly overcoming conduction losses.

## What about the noise?

Large convection ovens generate a lot of noise from fans and air movement or turbulence. This causes health and safety implications.

Infrared ovens with low air movement cause less noise.

## Can you heat in vacuum?

With convection it is not possible.

Infrared emitters can be used to heat components in a vacuum chamber.

## What happens in a "dirty" environment?

Combustion products, recirculation of dust etc. make convection unsuitable for "clean" applications.

Infrared heat is clean, no combustion products and no need to recirculate air.

## What can you say about adjustable control?

Difficult and expensive with convection (more air nozzles) at different air temperature and air speed.

It is easy to achieve infinitely adjustable control with infrared emitters by selection of energy densities, wavelengths, and variable power levels.

## How well does it heat three-dimensional shapes?

Convection has an edge with even heating especially with radical 3 dimensional geometry. Circulated hot air will cause all surfaces reach the same temperature.

Infrared has advantage on 2 dimensional parts and heats by line-of-sight. "Hidden areas" will be heated only by conduction through the material.

*It should be noted that metallic parts conduct heat very rapidly to hidden areas, and a properly designed IR oven uses a “booster” section up front and gives the part soak time to conduct through the part. Even so, process times can be considerably faster with a booster and soak section than with convection alone. Many manufactures now combine both technologies – booster and convection – to get the best of both technologies.*

## How about holding part temperature?

Convection oven at 200 degrees C air temperature will hold part at temperature without this temperature being exceeded, but limited in maximum air temperature only.

Holding with infrared employs electrical controls to prevent temperature increasing or decreasing, generally from a closed loop automatic system.

## How is the flexibility with mixed batches?

Although components heat up at different rates, they never exceed temperature of convection oven.

Infrared heats up components at different rates and will reach different temperatures depending on mass. Care should be taken to “group” like parts size and mass.

What about the design of the ovens?

For convection ovens product testing generally is not necessary. Although simple, it results in larger sizes and longer oven times

Infrared ovens normally require advanced product tests to determine oven design (power, wavelength, density, length, zoning, etc).

What can be used for "Class 1 Applications (high solvent)"?

Convection ovens are more easily designed for use in Class 1 areas. Again the trade off is simplicity for size and efficiency.

Infrared systems are more complex to use in Class 1 areas, and like convection will require large amounts of air flow to remove solvents, and interlinks between IR source and conveyor to shutdown system in case of line stoppage. The advantage is size (reduced footprint) and throughput. A combination of IR and convection may be the best solution.

Which oven type is more common?

Convection is widely known and easily accepted. It is easy to use and requires little training.

Infrared is a more complex system, that offers many more advantages: smaller footprint, less power consumption, zoning, closed loop control, quick start up and shut down. Although not as widely used as convection, infrared systems are quickly gaining acceptance as an alternative to the standard convection technology.

How do you calculate power?

For convection you make a simple mass x specific heat x temperature rise calculation to provide information for oven design.

For IR, normally tests are required to determine design.

Can you heat non-conductive materials?

In a 200 degrees C convection oven, the complete component will eventually achieve 200 degrees C.

Infrared ovens require more planning than convection for 3 dimensional objects. Because conduction cannot be relied upon to heat hidden areas, care is taken to design oven to equally heat all surfaces. Design and control is key to a good job.

How does color-reflectivity-transmission of material influence oven design?

Convection oven will have always the same design and characteristics.

Infrared systems are custom designed to suit substrate being processed.