Chapter Eleven
Powder Curing Process

Baking Needs for Powder Coatings

THERMOPLASTIC POWDERS
- Enough heat to liquefy and smooth out coating film.

THERMOSET POWDERS
- Sufficient heat to liquefy film
- adequate time at the specified bake temperature to develop full design properties.

Although the bake/cure process generally follows after the coating is applied there are instances when it's preferable to heat the substrate first.

- With cast iron/aluminum, preheating allows trapped gases to escape from the porous metal surfaces and reduces the tendency for blisters to form in the film.
- When the mass of the part is sufficient to allow residual heat to adequately cure it.
- If higher than normal film thickness (greater than 6 mils) or fast film deposition is required.

Factors Affecting Cure

- Powder Chemistry
- Type of oven
- Metal thickness
- Temperature/Voltage/Wavelength
- Bake Time
- Oven Efficiency
- Air Velocity

Recommended cure times are based on time at METAL TEMPERATURE.

Stages of Cure Development

MELT POINT
- Powder particles begin changing from a solid to semi-liquid state,

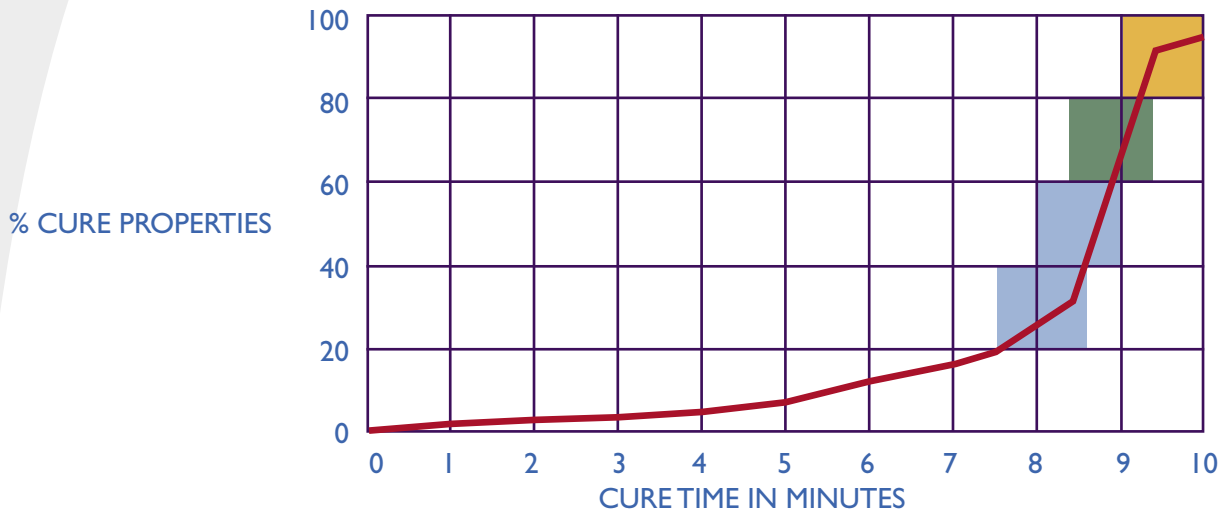
FLOW STAGE
- Powder is fully liquefied, reaching lowest viscosity, allowing film to smooth out,

CROSS LINKING STAGE
- Sufficient, sustained heat triggers large scale reaction within film, initial steps to total chemical/physical change of product.

GEL STAGE
- When sufficient crosslinking has occurred, for solidification of the film from a liquid to a solid.

CURE DEVELOPMENT
- The final, and most critical stage whenbaking results in reaction of majority of crosslinking sites and development of full design properties.

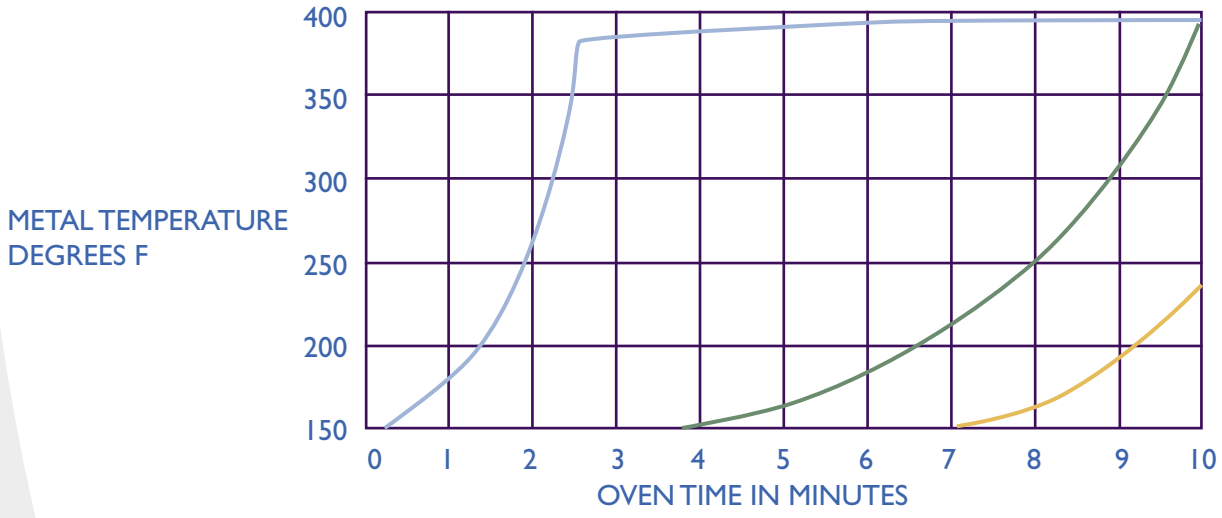
Typical Cure Development



- Assume all cure times are at metal temperature
- 75% of properties develop in last 15% of cycle
- Various properties develop at different stages

Phyisical properties develop first | Envirionmental properties next | Chemical and full properties last

Importance of Metal Thickness

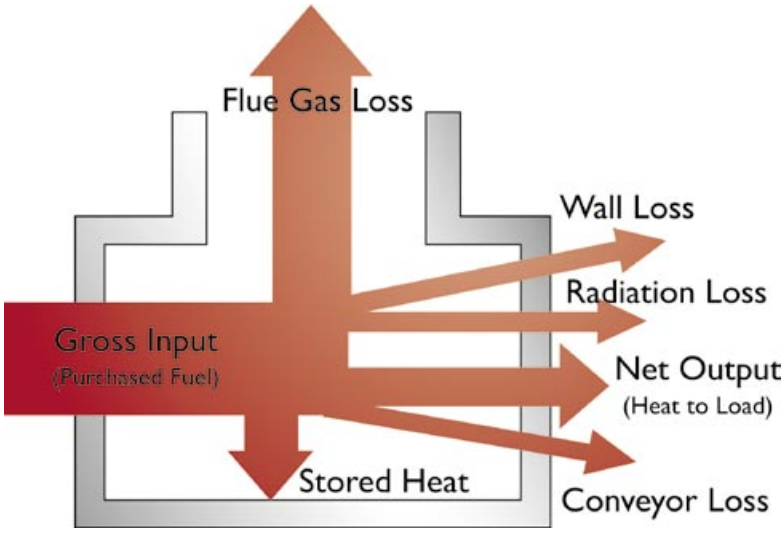


If cure requires a metal temperature of 10 minutes at 400° F. When is the start time?

1/16" Thick sheet metal | 1/4" Thick forged bracket | 3/4" Thick cast iron yoke

Bake Oven Designs and Energy Consumption

- Convection
- Infrared
- Ultraviolet
- Electron Beam
- Induction



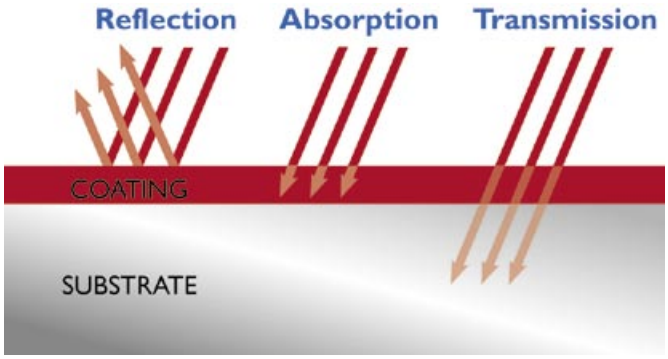
IR Curing Sources

- REFLECTED ENERGY - energy that bounces back.
- ABSORBED ENGERY - energy absorbed by the coating (usually by the pigment).
- TRANSMITTED ENERGY - energy that passes through the film where the substrate either absorbs or reflects the energy.

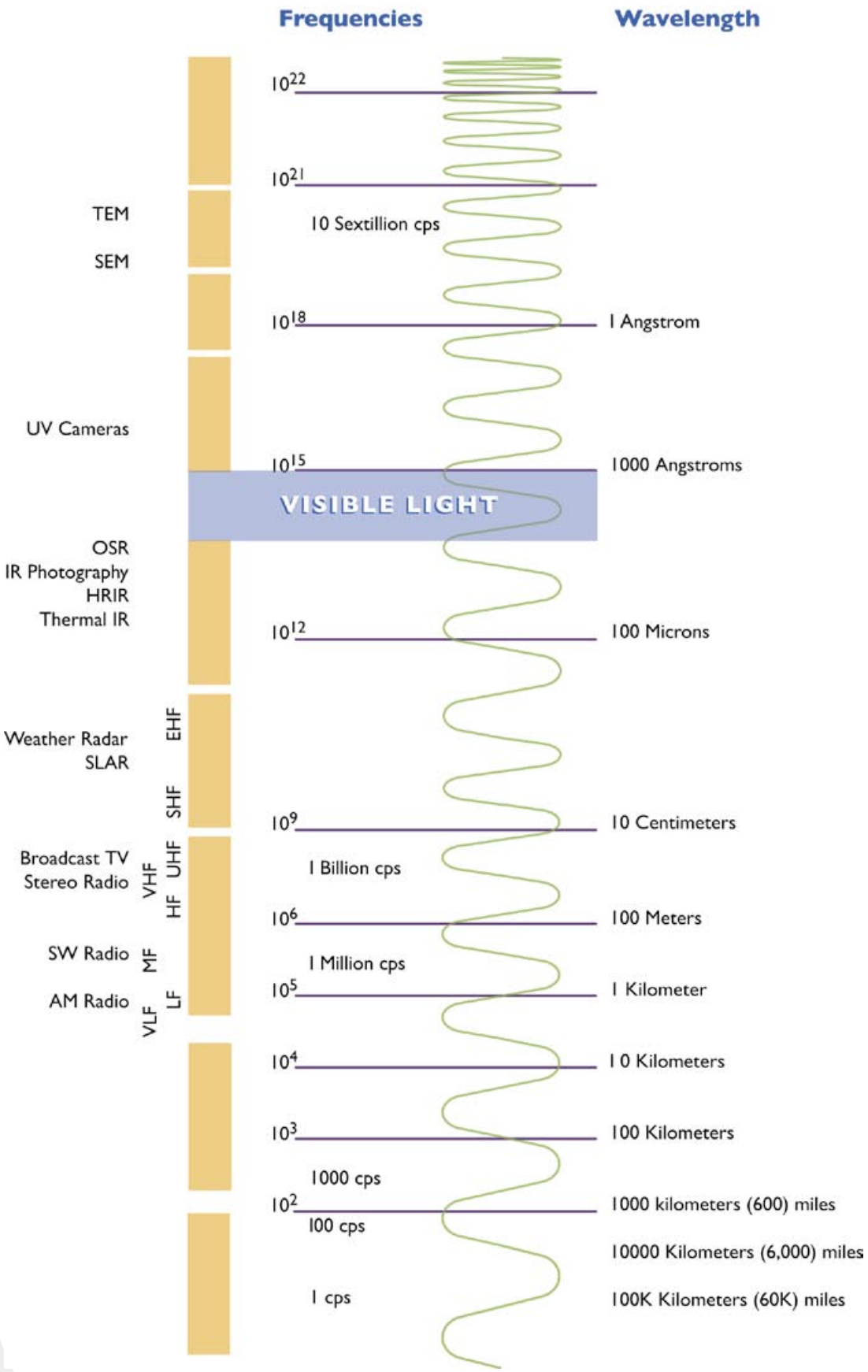
Different wave lengths have different curing properties to be considered.

- SHORT WAVE - 0.76 to 2.3 micron wave length with a source temperature of 2000° to 5000° F.
- MEDIUM WAVE - 2.3 to 3.3 microns with a source temperature of 860° to 2000° F.
- LONG WAVE -3.3 to 1,000 microns with a source temperature of 100° to 860° F.

Organic coatings with C-H and O-H bonds have a peak absorption in the 2.2 to 3.3 micron wave length range.

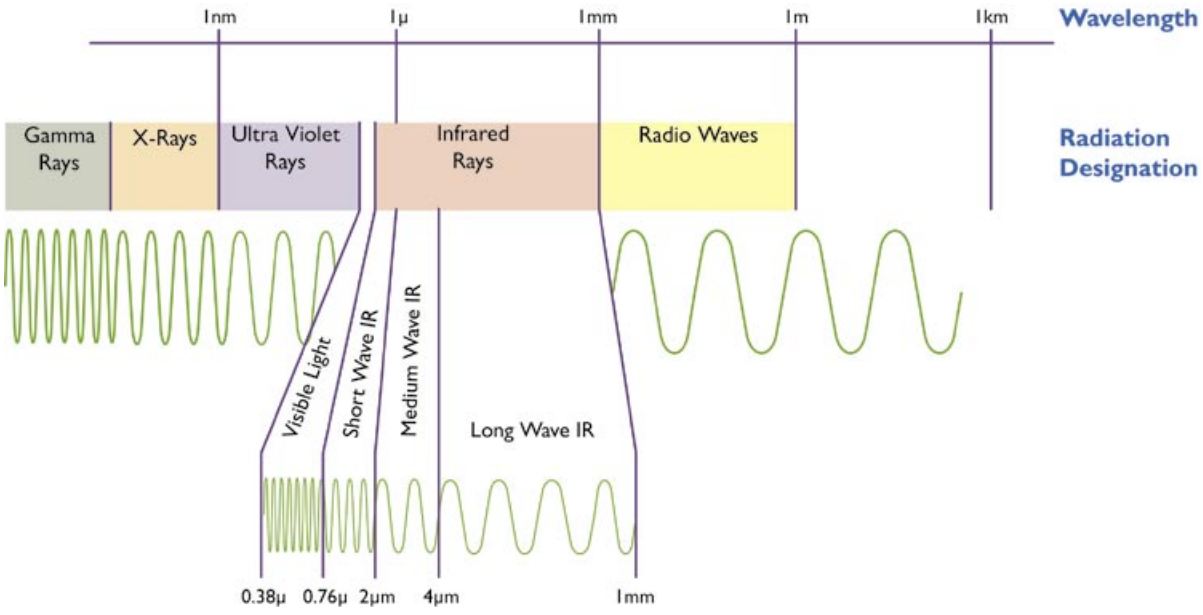


The Frequency Spectrum



1 Angstrom = 10^{-8} centimeter; 1 Micron = 10^{-6} meters

Radiation Chart



Optimum Infrared Wave Lengths