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Research & Development Division

Comparison of MW, IR, RF & Conventional Heating Systems

S r No	Parameters	MW System	IR System	RF Systems	Conventional Systems
1.	Rate of heating & drying cycles	Faster, it vibrates and rotates the atoms/molecules of object materials after absorbing MW radiation, which resulting in rise of the temperature of object	Faster, electromagnetic radiation gives up its energy to heat material	Faster, space charge displacement causes the material to heat rapidly throughout its mass	Slower through conduction from surface of object in core.
2.	Penetration & uniformity	Best, due to depth of heat penetration is higher in Microwave heating & uniformity archive with the help of mode stirrer /indexing of object materials.	Good, due to infrared heaters heats from surface therefore depth of heat penetration is lower.	Best, due to RF heats from within the material and even temperature gradient throughout the material. Heat penetration is based on dielectric properties of object materials.	Good due to conduction based
3.	Self- limiting	Rapid heating of material without overheating the surface. Material can be volumetrically heated and processed at low temperature so product quality is improved	Rapid heating on surface and further heating through conduction of object materials.	Heating rate is proportional to volatile matters in the material, which improves product quality by avoiding overheating.	Heating rate is not absolute proportional to product profile and that is why, it is not self-limited and resulting hot spots on the product.
4.	Moisture leveling & profiling	Microwave energy provides uniform energy distribution. This result in more uniform temperature and moisture profiles, improved yields, and enhanced product performance.	Less moist area in a product may get overheated and which results as less consistent	Wet areas heat faster than dry areas within a product, which provides more consistent quality	Less moist area in a product may get overheated and which results as less consistent
5.	Selective heating	Microwave field energy will be converted to heat by different amounts in different parts of the system. Selective heating of different parts of the material is possible.	Radiation heating is the transfer of heat using invisible electromagnetic waves of energy from a heat source to the object to be heated	Different materials heat at different rates so it is possible to heat only one part of a composite material, which improve product quality by not heating sensitive materials	Overheated spots may achieve on sensitive parts of materials
6.	Instant Start and Stop	Heating of materials are due to molecule movements hence no chamber warm up time is required	No warm up & cool down time required, saves time	No warm up & cool down time required, saves time	Warm up time required to achieve certain temperature on which product is to be heat treated
7	Space Required	Better floor utilization index as it doesn't require chamber area	Compact system providing better floor utilization index	Does not require larges space hence offers better floor utilization index	Poor floor utilization index as it require bigger chamber area for material to rotate
8	Energy Efficiency	100% energy utilization, as heating takes place within the material	100% energy utilization, Heats only desired spot of material.	Energy goes into the product without losses to the environment.	More energy is required
9	Maintenance	Typically, the only part that requires maintenance is the magnetron.	Durable and can be easily maintained and cleaned.	Maintenance operation simple	More parts in the system , maintenance needed
10	Environment issues	Environmental friendly and green heating solution, no carbon emission	No risk of prolonged exposure	No combustion by-product	Produces carbon or toxic gases hence not much environmental friendly heating solutions.
11	Cost	Microwaves generate higher power densities, enabling increased production speeds and decreased production costs	Costs for infrared ovens are comparable to convection ovens, and they can be less expensive	More expensive than convection, radiation or steam. Complex design w.r.t. dielectric values of materials and impedance matching ckt. etc.	High capital & operating cost is required to achieve good environment
12	Self lives of materials after heat-treatment for sterilization, disinfection etc	Highest due to deeper penetration depth in food solids and effect of heat-treatment on insects.	Poor	Moderate	Poor