Process Technique for Inert Environments

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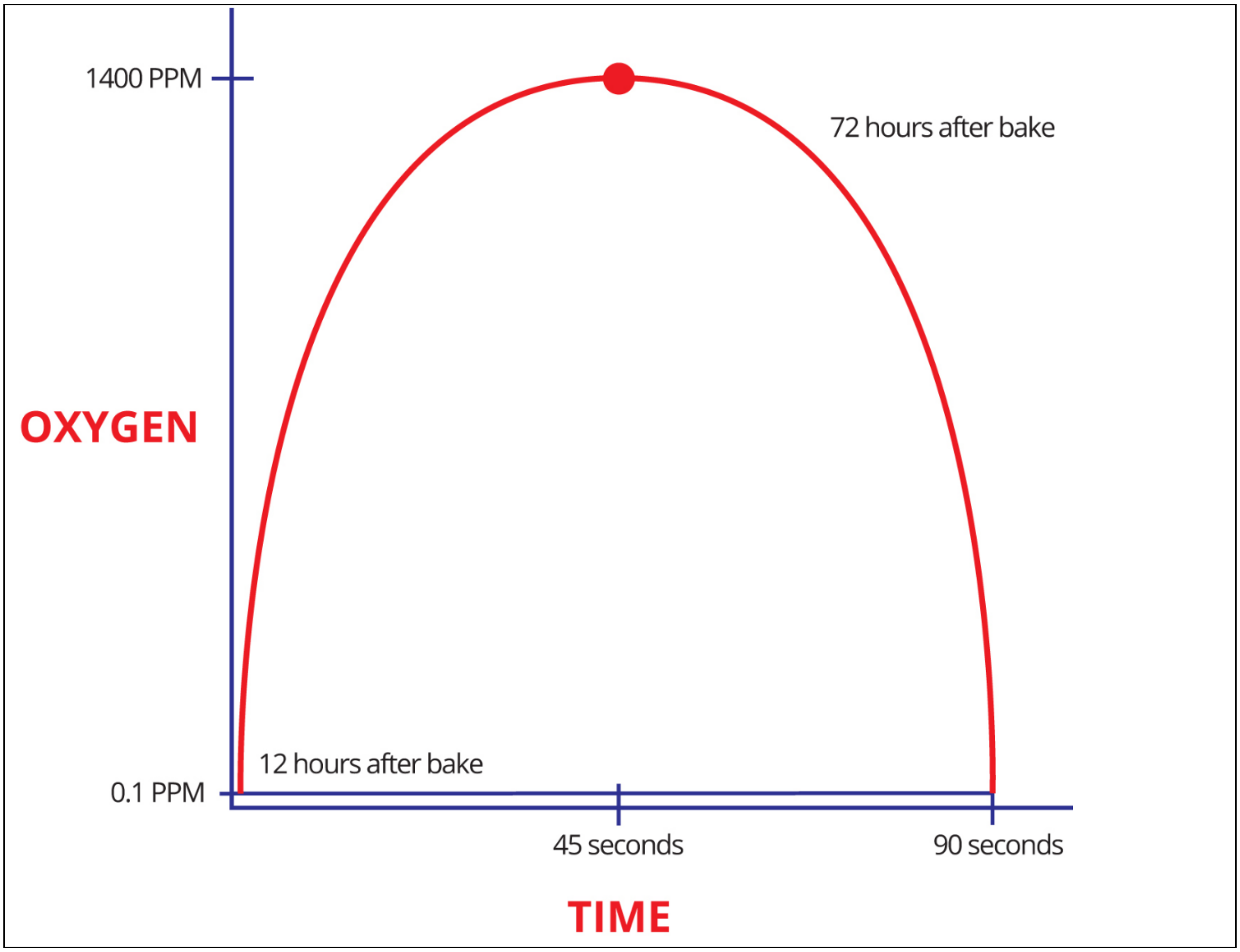
Modern inert environmental systems provide a range of capabilities, including rapid response moisture and oxygen monitors, pressure, and temperature control. These systems feature integrated, programmable vacuum nitrogen bake ovens for pre-seal moisture removal. The proper operation and process techniques of these tools influence the purity of the inert environment sealed into the hermetic package.

Oxygen contamination is one example. A variety of manufacturers' gloveboxes identify a correlation between bake time termination and oxygen contamination in PPM. The longer the packages sit in the oven following termination of vacuum bake processing, the higher the level of oxygen exposure to the packages. While the level of oxygen contamination can be reduced by retaining a vacuum in the oven, it cannot be prevented until the packages are unloaded into the inert atmosphere.



Oxygen in Hermetic Electronic Enclosures

Hermetic encapsulations are typically sealed in inert atmospheres, primarily nitrogen. Pure helium or argon can also be mixed with pure nitrogen and the mixture used to seal devices. Nitrogen, helium, and argon are chemically inert, unreactive gases posing no functional reliability or quality risk to sealed devices. In contrast, oxygen is chemically reactive. Its presence raises the possibility of chemical reactions with package materials in headspace that could introduce functional reliability risks to products.

While there are several risks associated with oxygen in the package headspace, moisture generation is of significant concern.

If any metal surfaces such as solder or seal ring material are exposed to headspace, oxygen in the headspace can oxidize the surfaces to metal oxide. If the bulk of metal in the package base or lid consists of Kovar alloy, it is well known that Kovar alloy volatilizes hydrogen gas over time. Oxidized metal surfaces are vulnerable to chemical reduction by this volatilized hydrogen. Water is the by-product of this reduction reaction, which could potentially lead to moisture-related failure mechanisms such as corrosion. The physical chemistry of this process is described by Ellingham in free-energy diagrams. The chemistry is especially favorable when silver is present (e.g., in silver-filled epoxy), but can also occur with nickel, tin, and other metals that may be present in sealed packages. This chemistry has been documented in detail.[1]

References

1. "Physics and Chemistry of Volatile Species in Hermetic Electronic Devices", P. wh Schuessler, 2013, pp. 28-37.