APPLICATION NOTE

Pb-Free No-Clean Solder Pastes Used in Vapor-Phase Soldering Process

Introduction

As companies within the electronics industry look for a solution for reflowing temperature-sensitive components (below 250–260°C maximum peak temperature), the use of vapor-phase reflow processes has increased. The temperature gradient of the traditional convection reflow systems is too large for their applications. Vapor-phase processes offer about a 1° variance from component to component on the circuit board, which would allow for a peak temperature of 230°C instead of the typical 240–245°C for traditional convection reflow systems.

The Vapor-Phase Process

It takes about 6–7 gallons of fluid to fill the average vapor-phase reflow oven. This inert fluid controls the peak temperature without the use of nitrogen. The fluid has a boiling point at a specific point (around 230–240°C for Pb-free materials). This means that if you are using a fluid with a boiling point of 230°C, the chamber will not reach temperatures hotter than 230°C. The fluid is then heated with heating coils at the bottom of the tank to the boiling temperature, which turns the liquid into vapor. The vapor rises into the chamber until it gets to the cooling coils, where it then turns back into a liquid and falls to the bottom of the tank to be reheated again. A circuit board will enter the chamber above the cooling coils after preheating and be lowered into the vaporous portion of the chamber. The vapors increase the board temperature uniformly until it is hot enough to reflow the solder. The board then exits the vapors above the cooling coils and enters the cooling zones.

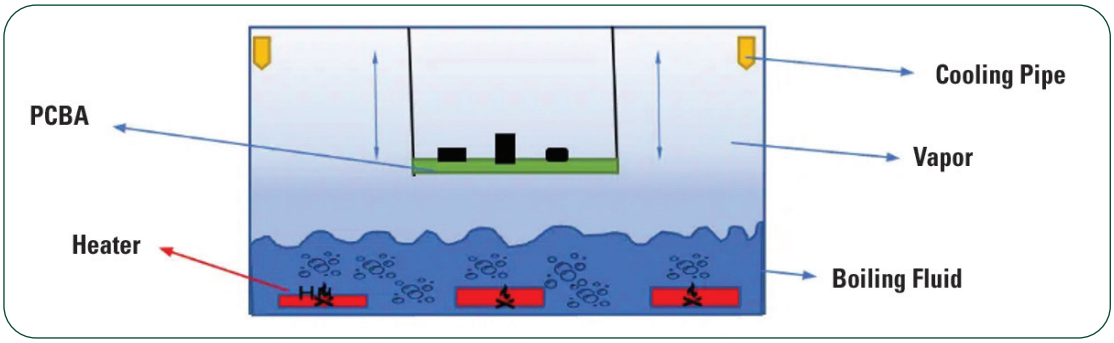
The fluid is relatively expensive, but the usage is small. This means the vapor-phase system could cost less than a traditional convection reflow system. A full cost analysis will help you decide which system to use. The vapor is inert and the exhaust is harmless to the environment. In addition, many machines come with an exhaust recovery system to minimize costs and fluid replacement. Filters are also available to remove impurities from the fluid. A small amount of fluid is removed from the tank and filtered through a canister filter, similar to an oil filter. The integrity of the fluid is monitored by thermal couples. If the temperature of the vapor varies by a few degrees, then it is time to change the fluid. Used fluid can be sent to the proper recycling companies, who will cleanse and resell the fluid to customers with less demanding tolerances for temperature variance.

Testing

Indium Corporation has tested several Pb-free no-clean solder pastes in various vapor-phase soldering systems. All performed to acceptable standards. The following flux vehicles have been tested in vapor-phase soldering systems:

- Indium5.7LT BiSn Solder Paste
- Indium8.9 SAC Solder Paste
- Indium8.9HF SAC Solder Paste
- Indium8.9HFA SAC Solder Paste
- Indium9.0A SAC Solder Paste

These solder pastes perform very similar in either vapor-phase soldering systems or standard SMT convection reflow ovens. In either case, the critical parameter is the reflow temperature profile.



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Soak Temperature

The soak temperature is critical to obtaining the optimum wetting characteristics of the solder paste. Each flux vehicle will have different wetting characteristics, with an activation range at which the solder paste will perform at its best. The activation range is defined as the approximate temperature where the activators in the solder paste begin to disrupt the oxide layers on both the solder powder and metallization to be soldered. This disruption of the oxide layer is the mechanism that allows the coalescence of the solder powder and wetting of the board and component metallization. The chart below provides the approximate activation temperature for each of Indium Corporation's Pb-free no-clean solder pastes.

Flux Vehicle	Activation Range (°C)	Soak Temperature (°C/sec)	TAL (°C/sec)	Galden Fluid (°C)	Min. Reflow Temperature (°C)	Max. Reflow Temperature (°C)
Indium5.7LT	95–125	Linear 1.5K/sec	165/60	D02 TS/165	165	185
Indium8.9	150–175	195/30	235/50	XS235/235	230	280
Indium8.9HF	150–175	195/30	235/50	XS235/235	230	280
Indium8.9HFA	150–175	195/30	235/50	XS235/235	230	280
Indium9.0A	150–175	195/30	235/50	XS235/235	230	280

Peak Temperature

Within the vapor-phase soldering system, the liquid chosen for soldering determines the peak temperature of the board. The preferred peak temperature for all of the mentioned SAC alloy no-clean solder pastes is 230–240°C.

Time-Above-Liquidus

Time in the vapor chamber can be varied to develop the desired time-above-liquidus. The preferred time-above-liquidus for Indium Corporation's Pb-free no-clean solder pastes is 30–90 seconds. When using a vapor-phase reflow system, a shorter time-above-liquidus may be used because the solder will become liquid at a faster rate than a traditional convection reflow system. The longer the time-above-liquidus, the thicker the solder interconnect intermetallic will become. Intermetallic strengthen the bulk solder joint, but an excessively thick intermetallic layer may weaken the solder joint.

Reflow Temperature Profile

To maximize the solder paste performance, a good soldering process should be implemented. To obtain the optimum soldering profile, four things should be considered: ramp rate, soak time, peak temperature, and time-above-liquidus. Vapor-phase reflow systems can provide very rapid and equal heating but have had limits on controlling the heating rate. Vapor-phase ovens are currently available with preheat zones, similar to conventional systems, to slow the heating rate. This minimizes defects, such as tombstoning, which can be caused by a slower heating rate.

All of Indium Corporation's solder paste and preform manufacturing facilities are IATF 16949:2016 certified.
Indium Corporation is an ISO 9001:2015 registered company.

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