Advantages of Vapour Phase Reflow for Lead-Free Soldering

Vapour Phase solder reflow found prominence in the early days of SMD production, and was once the most widely used method of reflow for this type of work. The benefits of Vapour Phase soldering have never gone away, the problems associated with the Vapour Phase process early in its development, it's almost exclusive use of CFC's and limited batch throughputs, are now no more than a memory as the new generation of Vapour Phase soldering machines provide an extremely viable reflow solution to the possible thermal and wetting problems arising from lead-free soldering.

The principle of Vapour Phase or Condensation soldering, involves immersing a populated PCB into a vapour, which has been created by a liquid with a specific boiling point. In the case of lead-free alloys, which generally have melting points of 217° or 221°C, fluid used would typically have a boiling point of 230°C. The heat of the PCB and components, when immersed in the vapour, can never exceed the boiling point of the liquid; this completely eliminates any risk of overheating. Any fluid residue on the PCB evaporates; the PCB cools prior to exiting the machine. Working with an assured maximum temperature of just 230°C for lead free alloys provides the least possible risk of any damage to boards or components.

Heat transfer to the PCB is accomplished almost irrespective of the shape, colour and thermal mass involved. For example, it is possible to solder such disparate items as a 0.5 mm thick PCB and an 18-layer board simultaneously. Both will get sufficient heat for soldering but neither will overheat. The Delta T will always be less than 5°C. Using VP reflow the physically defined and unchangeable heat transfer of the condensing vapour means that there are no variations in the process as long as the physical properties remain the same. This ensures consistent repeatability and reproducibility; the only requirement is the presence of vapour.

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The smaller process window determined by the use of lead-free materials and the process changes this will necessitate for assemblers, is likely to create several reflow problems. Not least of which is the problem of 'pop-corning' in plastic BGA's. The humidity contained within the hygroscopic plastic of the BGA can result in high pressure whilst it is being reflowed, which in turn can cause delamination of the substrate, or 'pop-corning'. This is likely to happen on the underside of the package, between BGA and PCB, and is very difficult to detect. The higher the reflow heat the greater the risk of steam pressure within the BGA. By using Vapour Phase for lead-free solder reflow with a maximum temperature of 230°C, this risk factor is minimised.

Whilst it is not necessary to create temperature profiles in the same way as other reflow methods, such as IR or convection, Vapour Phase manufacturers have recognized that the diverse range of products PCB Assemblers are likely to encounter, both now and in the future, may require differing heating ramps. For example: the user of an IBL VP machine has several ways of controlling heat transfer, in addition to the optional IR pre-heating chamber, there are 20 optional steps within the vapour chamber. Each step can be programmed for a predetermined time in order to create an infinitely variable heating ramp. Additionally the heating level of the vapour can be varied; by using these adjustments virtually any heating ramp can be created and stored within the machine software.

The Galden PFPE fluids which are used today, (no CFC's), are available with a range of boiling points. Having a higher molecular weight, the vapour density of these fluids is greater than that of air; all other gasses are held above the vapour blanket creating a 100% inert soldering atmosphere. There is no need for nitrogen or special process-enshrouding equipment, Vapour Phase reflow soldering is itself an inert atmosphere process with an oxygen level of 0 ppm. In view of the inferior wetting ability of lead free alloys compared with Tin Lead (SnPb) solder pastes, the inert atmosphere of Vapour Phase, provides the best possible reflow conditions for good wetting.

Excessive fluid usage is no longer an issue; today's machines are designed and built for maximum efficiency and low operating costs. Typical fluid usage for an IBL batch machine is between 7 – 10 grams an hour, equating to around 70p an hour, and for a large IBL in-line system 10 – 25 grams an hour.

Vapour Phase reflow is suited to a wide range of production requirements, from prototyping and small series output to major production runs. A typical soldering cycle for lead-free production lasts about four to five minutes, the number of boards that can be placed on a pallet determines the throughput. There is a wide range of machine sizes and variations for higher throughputs and automated production. Using an automatic system you are also able to interrupt throughput at any time and manually load different boards without making major adjustments to the machine. The hand-loaded boards will be soldered in the normal way, and the interrupted production line restarted. Additionally, IBL batch machines can be easily upgraded later to in-line. These are further examples of the flexibility of Vapour Phase machines.

Machine footprint of a Vapour Phase machine is much smaller than a comparable convection system that may need to include several heating zones, in order to achieve the required temperatures for lead-free reflow. For this reason also, electrical consumption of a Vapour Phase solder reflow machine is lower than alternative methods. Operator maintenance requirements of Vapour Phase machines are virtually nil.

Vapour Phase reflow in an inert gas atmosphere is not only a benchmark for other procedures, it defines it's own unique standard. The heat transfer is highly reliable and reproducible. All IBL VP machines can be used for SnPb or lead-free alloys without any modifications or additions.