Vitronics Soltec

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The effect of radiation wavelength on preheating results

Other relevant documents: Information Sheets 004 and 036

Introduction

Although the "long wave" preheating system with calrod elements for predrying the PCBs to evaporate the solvent from the flux is one of the best systems, it has its drawbacks when a mix of boards with different heat demands have to be soldered.
Also the demand for the preheating of fluxes which need higher temperatures, or the thermal requirements for certain SMDs may ask for a system that will respond faster than the calrod elements.

On the other hand one must prevent thermal damage to (conventional) components due to a too high temperature.
This sheet will give information about what to expect from different types of preheating systems.

Effect of different preheating systems

Calrod elements can be used up to an element temperature of 500°C.
This means that the infrared radiation spectrum is ≈ 4 - 10 microns, so the radiation is in the far infrared region of the spec-trum.

The benefit is that this type of preheating has a combination of radiation with convection, which is good for predrying the flux.
An other advantage of long wave radiation is that almost all the heat will be absorbed by the board, without energy loss of radiation through the board which is common for short wave radiation.

A drawback of this preheating system is that it takes a relative long time to change to a higher or lower element temperature setting, since the increase or decrease of the temperature setting is 1 K/s, which means that it takes about 1 min to change from 450°C to 500°C.

Middle wave twin quarts heaters are reacting much faster to a change in temperature settings, 3 - 4 K/s.
The radiation spectrum, depending on the element temperature, has a range from 2.5 - 6 microns.
The maximum element temperature is 800°C.

These elements with a length of 1 meter can be covered with glass plates.
These glass plates protect the heaters and will also act as radiation transformers due to the partial absorption of the radiation energy from the elements.
These glass plates will therefore also act as secondary emitters.
The glass plates will transform a substantial part of the radiation to a wavelength range of 6 - 8 microns and they will also diffuse the focusing of the heaters and so prevent hot spots on the boards.

The heat transfer capacity is much better than with the calrod elements, since the heat transfer with radiation energy is related to the forth power of the element temperature.
So it is possible to use higher transport speeds in relation with the calrod elements and still get a good preheating on the board without the risk of overheating components.
Since the system gives the best mix between preheating capacity and easy changing of the settings, you can see it as the most universal preheating system.

Short wave preheaters are reacting almost as fast as light, due to the fact that the wavelength of the radiation is in the region < 2 microns.
This means that this system is very flexible when boards lot size one have to be soldered at different preheating temperature settings.
It is possible to use a section of these elements in combination with calrod elements.
The first calrod element sections provide the "basic" preheating, while the short wave quarts section can boost up the temperature to the desired level.
In this way it is possible to change the preheat menu from board to board.
Of course it is also possible to add such a section in series with the middle wave twin quarts heaters, provided that there is sufficient space in the machine.

Although this short wave preheaters give a very flexible preheating system as far as the wish for different preheating demands on different boards is concerned, they also may give a draw back.

The problem with the short wave preheating is that a substantial amount of the radiated energy will be transmitted through the PCB, even when a glass plate is covering the elements.
Although the glass plate will partly act as secondary emitter, the very short waves < 1.5 microns will pass the glass plate.
The board material is also transparent for this short wave energy, which means that the transmitted energy will now be transferred to the components on the component side of the PCB.
As a result these components may get a too high temperature in the solder process due to this preheating effect.

It is therefore important to use these elements at low output settings, so that the energy will be mainly transmitted in the more medium IR wave length spectrum.
Only in case of soldering multilayer boards the higher output settings can be used without the risk of over heating the conventional components such as capacitors.

The use of a "tunnel" reflector, and/or topside preheating, will not so much add to the preheating capacity for the solder side of the board, but may give a substantial increase in temperature of the topside mounted components.
This is in most cases an undesirable side effect which has to be taken in account when one wants to use a preheater tunnel cover.

Effect of the soldering process on components

The answer on the question if components will withstand the soldering process without any degradation has to be found in the product documenta-tion from the component supplier.

In such documentation mostly several soldering process profiles, including preheating, are given.

If some leaded components are more sensitive for high temperatures, one can sometimes use longer lead lengths on the component side, between the solder joint and the component body, e.g. by using a stand off or a kink in the wire, to reduce the temperature of the component during the solder process.