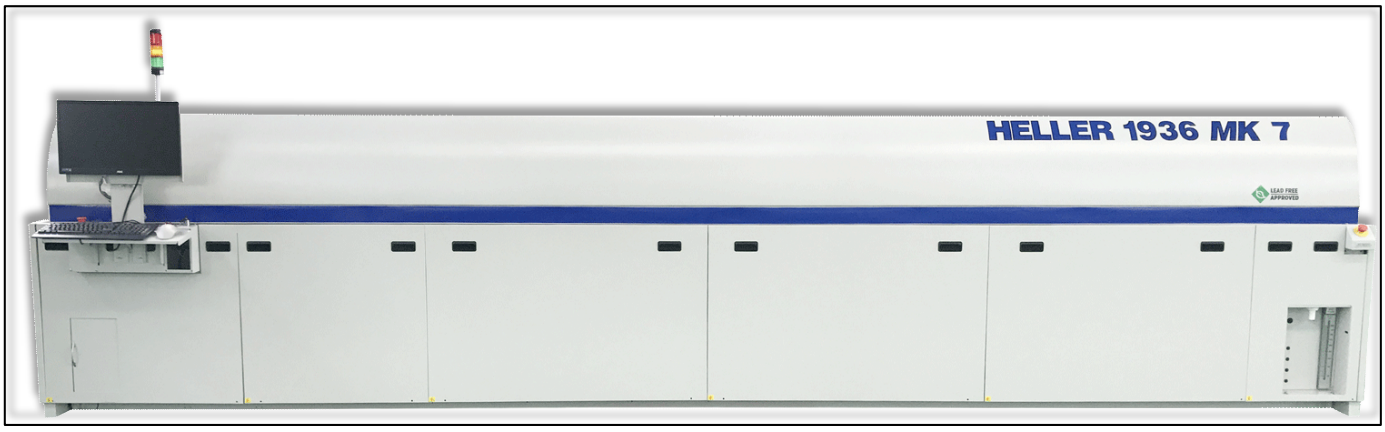
Development of a proportional flow control (PFC) system to provide improved gas blanketing in a closed-loop process for the Heller Industries Inc ranges of solder reflow ovens

Introduction

With the rapid growth of the electronics industry, solder reflow ovens are used to attach surface mount components to PCBs more quickly and efficiently using solder paste; this must be done in an inert atmosphere, as even ppm levels of oxygen from residual air in the oven can affect the end results leading to a poor solder. Nitrogen gas blanketing is used to flush oxygen (air) from the oven during the process to provide an inert atmosphere and this, combined with the controlled heating and cooling zones of modern solder reflow ovens, promotes improved wetting angles and shinier solder joints by preventing oxidation of the metal.



An example of one of the Heller solder reflow ovens.

Issues

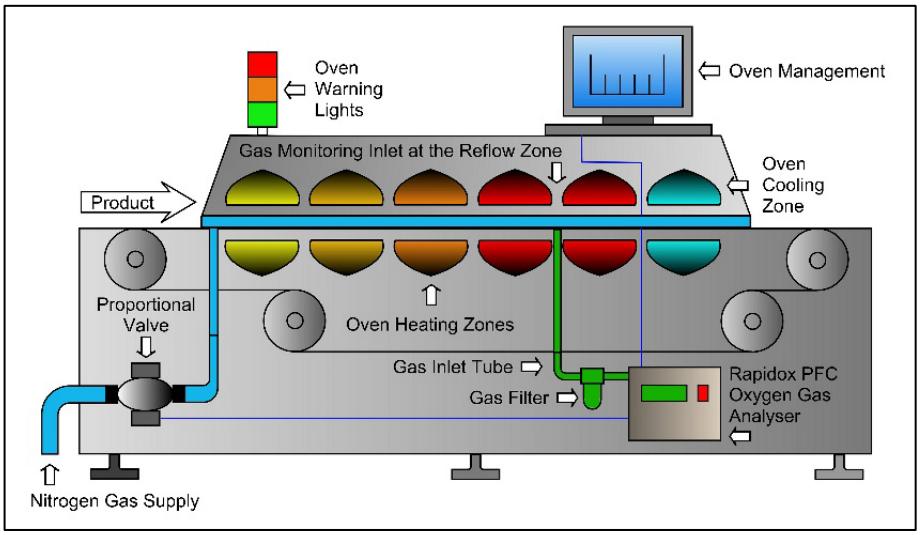
Clearly, the most effective way to ensure that the nitrogen gas blanketing is working as expected is to measure the atmosphere in the oven continuously and accurately; the use of an on-line oxygen analyser that measures sub parts per million (ppm) levels at selected points in the solder reflow oven provides this security, and Heller used the Rapidox 1100 oxygen analyser as this could be moved around as required for normal “open-loop” measurements when and where required.

The Rapidox 1100 used on Heller solder reflow ovens

It soon became clear, however, that an analyser which was a permanent oven installation and could output to the oven control software for feedback to provide process control of the nitrogen gas blanket (a gas flush) would be useful in the event of a leak and the ingress of air.

The Solution

Cambridge Sensotec collaborated with Heller engineers to develop a proportional flow control (PFC) system to regulate a proportional flow valve (PFV) for oven control using proportional-integral-derivative control (PID) software. This PID software is used to control the value of oxygen in the oven via a 4-20mA signal from the analyser to the PFV, and the actual oxygen level rises and falls between specified parameters over time as the PFV opens and closes to maintain the acceptable range. This is known as a "closed-loop" process and enables tighter quality control to be maintained by maintaining a pre-set ppm level of oxygen within the reflow tunnel.



Schematic of Heller Solder Reflow oven showing a Rapidox PFC analyser relative to the Proportional Flow Valve for closed-loop process control in a solder reflow oven.

The analysers developed by Cambridge Sensotec for closed-loop applications in Heller solder reflow ovens is the Rapidox 1100ZR-PFC range and Heller use both a single channel version for standard ovens and a three-channel version, the Rapidox 1100ZR3-PFC, for larger solder reflow ovens, where measurement of several stages of the process is necessary. As well as significant software changes, the rear panel is customised to accommodate the 24V DC supply in the machine and to enable connection with the proportional flow valve.

Rapidox 1100ZR3-PFC customised rear panel (24V power, PFC valve output)