THE DIFFERENCE IS THE DETAIL SOLDERING PROCESSES RETHOUGHT

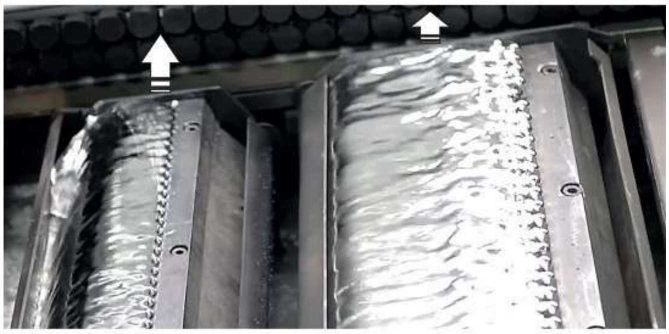
BY DR.-ING. ANDREAS REINHARDT, DIRECTOR RESEARCH & DEVELOPMENT AND HEIKE SCHLESSMANN, MARKETING, AT SEHO SYSTEMS GMBH

Electronics manufacturers are facing daily challenges to be competitive in a global environment. The quality of the manufactured products, price pressure, and manufacturing process sustainability are just some of the tasks to place the future of electronics manufacturing on sound footing. Equipment suppliers can efficiently support this. SEHO Systems GmbH, one of the leading manufacturers of complete solutions for soldering processes and automated production lines, is in close contact with customers worldwide. Energy-efficient machines, flexibility, a higher degree of automation in terms of process control, and reduced wear susceptibility are major approaches for the beneficial support of electronics manufacturers. SEHO scrutinized the soldering processes and refined them in this direction.

Approximately 70 percent of the electrical energy consumption of a wave soldering system is needed to preheat assemblies. In regard to energy efficiency, several aspects of a machine must be considered and, depending on the product mix, more than one may need to be optimized to achieve the best energy efficiency.

In “shut off” mode, the machine typically needs a longer period of time to prepare for production. In the “standby” mode, the machine only needs a few minutes to reach the ready state. If the machine is in the “no load/ready” mode, a product can enter any time because there is no product in process. In “variable load” mode, fewer products enter the machine than it would be able to process. Maximum throughput is reached in “100 percent load” mode.

Due to increasing product variety and lower batch volumes, advanced technologies are required to achieve constantly good solder connections. Otherwise, it would be necessary to set up several small machines instead of one large one. This, however, would raise costs in terms of floor space requirements, maintenance requirements and energy consumption.

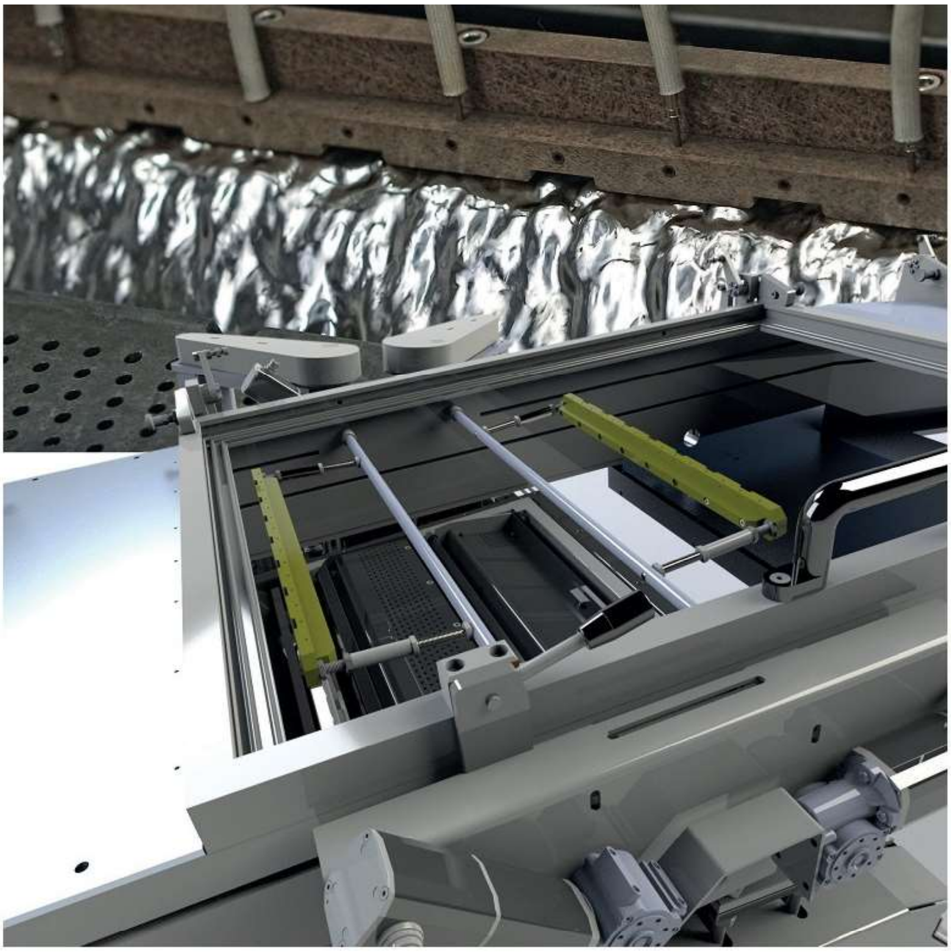


ENERGY-EFFICIENT SOLDERING PROCESS

The energy consumption of a wave soldering system can be reduced for “no load” as well as “variable load” modes by using a new type of fast reacting pulsar heaters in the preheat area. These heaters can switch between parameter settings from one product to another without delay.

There are three factors that play a major role in achieving remarkably reduced energy consumption:

- When the machine is empty and changes into standby mode, the heaters can be set to a minimum, since returning to a work setting takes only seconds. The necessary power to keep the environment in the machine on a constant level is about 3.5 kW. This minimal energy supply is enough to effectively keep the temperature level in the tunnel, avoiding any influence on the temperature profile of the products.
- If the load is less than 100 percent, all heaters not having a product running above them can be switched to a standby setting. Therefore, fewer loads are linked directly to a lower energy consumption.
- One of the main benefits of the new pulsar heaters is their quick reaction time. When processing various products with different thermal



demands that require different parameter settings, no waiting time between the product groups is necessary. Configuring emitters individually, instead of using entire segments, helps to realize the shortest assembly distances. This means that each of the heaters below the product is activated with the particular setting for this product, with no setting adjustment needed for the next product.

As a result, the wave soldering system achieves an outstanding flexibility, which is the basic prerequisite for cost-efficient, high-mix operations without throughput loss.

> "DUE TO INCREASING PRODUCT VARIETY AND LOWER BATCH VOLUMES, ADVANCED TECHNOLOGIES ARE REQUIRED TO ACHIEVE CONSTANTLY GOOD SOLDER CONNECTIONS. OTHERWISE, IT WOULD BE NECESSARY TO SET UP SEVERAL SMALL MACHINES INSTEAD OF ONE LARGE ONE."

FLEXIBILITY ALONG THE LINE

Flexibility in the preheat area can only reach its full effectiveness if there is also flexibility in the soldering area. Most wave soldering systems installed in electronic productions are equipped with one or two solder nozzles that generate a turbulent wave. This configuration is ideal for most products; however, this concept reaches its limitations if, for example, PCBs in masks are to be processed. Generally, the packing density on both sides of a PCB increase and the portion of SMD components located on the soldering side of the THT components is continuously growing.

Switching the process to selective soldering is not always an option. If the existing wave soldering machine is used for these applications, soldering masks are an effective solution. Soldering masks eliminate an additional process step where SMD components are glued before they are soldered with the THT components. When using soldering masks, particular areas on the assembly such as SMD components or temperature-sensitive components are covered to prevent them from being wetted during the soldering process. The reliable wetting of all solder joints, however, is not guaranteed, depending on the thickness of the mask and the size of the cutouts. Additionally, it might be challenging to achieve a reproducible process if the distances between covered SMD components and the THT pins to be soldered are too small. Sophisticated assemblies that are processed in soldering masks often show soldering defects such as incomplete solder joints or solder bridges. Thus, these kind of applications require new solutions.

HIGHER PROCESS RELIABILITY WITH AUTOMATION

Automatic nozzle height adjustment that does not influence the wave soldering system's cycle time provides an innovative approach for these applications. The height of each solder nozzle can be adjusted via the software within a total distance of 20 mm, creating the optimal product-specific distance between circuit board and solder nozzle. The automatic nozzle height adjustment provides additional process reliability and better product quality because all solder joints will be reliably wetted and a component-specific defined solder peel-off will be enabled.

The system is linked to the sector soldering feature. This function allows program parameters for pump revolution speed (wave height) and conveyor speed individually for up to 16 circuit board sectors. By adding the individual nozzle height, i.e. the optimum distance between PCB and solder nozzle, at up to 16 different circuit board sectors, this system provides a large process window and maximum flexibility. It also ensures sustainability of the wave soldering machine with regard to future applications.

> "THE ENERGY CONSUMPTION OF A WAVE SOLDERING SYSTEM CAN BE REDUCED FOR "NO LOAD" AS WELL AS "VARIABLE LOAD" MODES BY USING A NEW TYPE OF FAST REACTING PULSAR HEATERS IN THE PREHEAT AREA. THESE HEATERS CAN SWITCH BETWEEN PARAMETER SETTINGS FROM ONE PRODUCT TO ANOTHER WITHOUT DELAY."

Automated process control systems increase the reliability and stability of the soldering process significantly. Additionally, they reduce the risk of potential soldering defects, thus decreasing overall manufacturing costs. The fundamental parts of a soldering system are monitored such as temperatures in the preheat area, filling levels of flux reservoir and solder pot or the transport of assemblies through the machine using appropriate sensors. However, the consistent height of the solder wave also is crucial for wave soldering processes. An irregular wave height can result in poor hole fill or incomplete wetting, and it is no coincidence that the wave height is automatically monitored and regulated in selective soldering processes.

Until now, it has not been possible to measure the wave height in conventional wave soldering processes without interrupting the production process and using external measuring instruments.

However, in this case, the result is just a momentary snapshot that does not provide any information about necessary parameter modifications and does not support automated feedback control. With a particular focus on this aspect, SEHO developed an automatic wave height measurement, built into the soldering section of the MWS 2300. The system is based on a contact measurement that produces reliable results and processes for laminar as well as turbulent solder waves.

A reference measurement is performed to determine the ideal state of the solder wave height. The measured values as well as the configured machine parameters are stored in the system. Following a customizable timetable, the system performs automatic measurements of the wave height in production mode by lowering a bar with sensor contacts onto the solder wave surface. Based on the measured values and a mathematical model, the wave height is adjusted automatically within configurable tolerances by modifying the parameters accordingly.

If the required settings are outside the defined tolerance range, the system calculates a recommendation. However, the machine operator or process owner needs to decide whether the wave height adjustment parameter modifications should be applied, or if the problem is elsewhere. All measured values and adjusted parameters are logged to ensure complete traceability, thus providing a proof of quality of the manufactured products.

The advantages are obvious: Deviations from the ideal state of the process can be recognized quickly, and potential causes can be eliminated promptly. This ensures highest product quality and reduces manufacturing costs sustainably as rework will be avoided.

FUTURE-ORIENTED AND RELIABLE: SELECTIVE SOLDERING

Selective soldering technology is one of the most future-oriented technologies in electronics manufacturing. It is energy-efficient and resource-saving, it delivers process-reliable results and, depending on the machine type, it can flexibly be used for different applications, also with high throughputs. However, compared to conventional wave soldering, it requires more maintenance – especially the soldering area – and there is a higher wear susceptibility with regard to the nozzle technology that is used. This is an aspect that burdens the overall cost structure in

FEATURECONT.

electronics manufacturing and, therefore, which SEHO put to the test as well.

The newly developed LongLife mini-wave solder nozzle significantly improves the selective soldering process. The nozzle is manufactured in a special process without damaging the cubic metal matrix. Contrary to the manufacturing process of a conventional cut surface, this new process does not change the arrangement of atoms at the surface of the nozzle material. Additionally, the mini-wave solder nozzle is coated with a special gold alloy. This combination gives the new solder nozzle some outstanding characteristics.

> "...THE WAVE SOLDERING SYSTEM ACHIEVES AN OUTSTANDING FLEXIBILITY, WHICH IS THE BASIC PREREQUISITE FOR COST-EFFICIENT HIGH-MIX OPERATION WITHOUT THROUGHPUT LOSS."

A particular benefit of the LongLife solder nozzle is its lifetime, which is more than three times than that of conventional solder nozzles under the same conditions. Therefore, the annual savings potential is remarkable.

Maintenance requirements for the nozzle are reduced as well. The LongLife solder nozzle does not need to be cleaned or reactivated throughout a complete production shift. Additionally, there is no activation needed prior to production start. Thus, the nozzle ensures increased machine availability since production does not need to be interrupted for manual cleaning or nozzle reactivation.

The new solder nozzle also provides benefits from the process-specific point of view. The consistent nozzle wall allows improved heat energy transfer to the solder joint, and the wave height is constantly kept stable, ensuring higher overall process stability and improved soldering

quality. In the case of poorly activated solder nozzles, the nozzle center may shift, resulting in solder bridges or washed away SMD components. The LongLife solder nozzle, however, permanently features perfect activation due to its material characteristics.

Also, the ecological footprint of the new solder nozzle speaks for itself. The LongLife nozzle is particularly resource-conserving, compared to conventional solder nozzles. Materials usage is remarkably lower and, due to reduced wear and elimination of chemical activation materials, oxides and dross are reduced as well.

CONCLUSION

Electronics manufacturing is in a continuous process of change. Sustainable production processes, the ability to react flexibly to new requirements, consistently high quality levels, and overall cost optimization are the goal. Innovative technologies help to establish more efficient processes and often are the small details that make the difference.

www.seho.de