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Temperature control for weld paste: a proposal for improvement in the SMT sector

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Abstract— *Due to the great technological advance in the most varied segments of the automatic insertion sector, little is concerned with the temperature control of the weld paste that will be applied in the printed circuits (PCB), used in the most diverse equipment. Knowing that the process of applying the weld paste is one of the first steps of the sector, great attention should be paid to the quality of the weldpaste used, because the low efficiency in this step will generate great impacts for the other, as well as can impact the end customer. In order to give due importance to this stage of the manufacturing process this article shows the reality between equipment that has the control and temperature adjustment through air conditioners coupled to screen printer equipment, and those that perform the same function, however, without the control and temperature adjustment of the weld paste inside the equipment during the use and application of the same in the printed circuits. Performing a comparison between the equipment, it was observed how much an improvement not implemented for the whole plant, generated considerable impacts to the production process, which if it had been made could in addition to generate higher profits for manufactures, also generate greater confidence and customer satisfaction before the ready product produced with more quality.*

Keywords— ***PCB, temperature control, weld paste, screen printer, SMT.***

I. INTRODUCTION

The process of automatic insertion becomes increasingly essential and critical in the manufacturing environment through the high use of electronic plates in the most diverse equipment of everyday life.

The weld paste is a metallic powder that contains tin welding and stabilized weld flow to form the metal alloy between the components and remove the thin layer of oxide that forms on the surface where welding will occur [1].

It began to be widely used around 1970, when the Surface Mounting Technology (SMT) industry began to gain more and more space in the market.

The weld paste has limited service life and is temperature sensitive, so it is necessary to comply with the thermal criteria so that the degradation of the paste by rheology (study of the viscosity of matter) is avoided [2].

Technology deployments and quality acquired through equipment have a direct impact on SMD sector efficiency in obtaining satisfactory results [3].

SMD components are found in integrated circuits, resistors, capacitors, inductives, diodes etc., because they have reduced casings, it is not necessary to perform the plate drilling for the welding process, which increases the reliability of the plates assembly and reduces the manufacturing cost and the size of the circuits [4].

A fundamental equipment to obtain optimal performance in the SMD sector is the Screen Printer, responsible for applying the weld paste in the PCB (printed circuit) where the electronic components will be assembled.

Printed circuits usually consist of a plate of phenolite, fiberglass, polyester fiber, specific films based on various polymers, etc. On these plates, through thin a film of copper, silver or alloys based on another, the conductive lanes that will be fixed the components will be drawn [4].

By indication, the most effective way to carry out weld paste deposit is through the stencil printing process, where usually the stencil is formed by a sheet of metal with openings that correspond where the weld paste should be deposited. After being applied on the stencil the weld paste is rubbed over it with a squeeturn. The printed circuit (PCB)

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is then removed and proceeds to the next equipment that will continue the automatic insertion process.

Also through the guidelines of the company in question, the main characteristics of the weldpaste are viscosity and thixotropy that directly interfere with the efficiency of the creamy mixture of metallic powder and flow additives that is the composition.

For the manufacture of circuits with SMD technology it is necessary a thorough control of heating in the realization of welding [3]. In order to ensure that this process is efficient, temperature control in both storage and use of the weld paste is essential, because through the main characteristics of the weld paste (thixotropy and viscosity) is that a satisfactory weldability is obtained.

The aim of this article is to analyze the efficiency of screen printing equipment in the SMD sector that have or do not have air conditioners coupled for internal temperature control.

II. MATERIALS AND METHODS

The scenario of the auto-insertion sector currently revolves around two technologies, Thought-Hole Tecnology (THT), which would be the use of components that pass from one side to the other in the PCB, and Surface Mount Tecnology, in which the insertion of the components is on the surface of the PCB which reduces the dimensions of the components [5].

The migration to SMT has not yet occurred completely since the impossibility of manufacturing large-scale components such as connectors, which need to be welded throughout its perimeter so that the contact area is larger offering a higher mechanical resistance when compared to the components used in the SMT [6].

There are factories that have both technologies, which allows a larger margin of customers served and a more complete production process in order to perform both functions.

Since the European Union banned the use of weldpaste that used lead (Pb) in its composition, through the great impact caused on the environment by this chemical element [7], it was exponentially the increase in the use of lead free, which are metal alloys that have only tin and flow in their composition.

These, in turn need a higher temperature for the melting point, which would be from 183 to 213 ºC, however came to be the alternative to the problems of lead weldpaste [8].

A series of parameters needed to be adjusted, from pcbs, as well as changes in components in the face of higher thermal exposure [5].

The study took place in a company of the industrial pole of Manaus/AM, which focuses on the production of radios and sets of automotive cockpits, with more than 10,000 employees, in more than 40 facilities, in18 countries.

A case study was carried out that analyzed and compared the difference between equipment in the SMT sector, which are responsible for performing the application of weld paste, with or without coupled air conditioning, in order to ensure the ideal temperature of the weld paste due to the importance of process efficiency.

III. RESULTS AND DISCUSSION

The Printer process is the most demanding, since printer configurations, cleaning of the materials used and attention to the environment where the folder will be inserted make this process an extremely important factor for satisfactory efficiency [5].

In an attempt to find the root cause of the problem, it was identified that only one production line had temperature control on the Screen Printer equipment. And when analyzing the factory's internal guideline, it was realized that it was an extremely important point for the efficiency of the process as a whole.

The control of the weld temperature is essential, as a large difference in temperature can damage the SMD components [9].

The weld paste must be between -26 and 43 ºC, because below the lower limit the weld paste enters the freezing process and above the upper limit the flow activation process begins [1].

In the storage environment, the company has a quality control of the weldpaste through a software that informs if the weldpaste is in a position to be used, as well as the shelf life, ensuring that there was no problem in transport to the factory that should be placed in polystyrene box with ice as specified by the manufacturer and storage form.

The specifications of the company in question provide that for the stored weld paste at a temperature of 10 °C or less, valid for 6 months. The stabilization time at room temperature should be four hours for containers with a capacity of more than 1kg and two hours for containers with a capacity of less than 600g, with storage at room temperature of 22 to 25 ºC of seven (7) days.

All these items were faithfully serviced and validated every day by the company's employees, however, with the

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implementation of temperature meters, in other equipment that perform the same function, in order to perform the monitoring of the internal temperature inside the equipment, detected that with the high use of screen printer equipment, the internal temperature was higher than 27 ºC , which compromises the quality of the weld during the application process in the printed circuit.

In October 2020, 144 tailings were identified for the weldpaste in the factory's production process, which meant 45% in discarded parts (scrap) with a cash value of approximately US$ 938.00 dollars.

Using as an example a Screen Printer equipment that does not have automatic control and temperature adjustment, it is possible to analyze the amount of defects related to a weld paste with low viscosity, which totaled 137 tailings related to the weld paste, generating impacts on the downtime, rework and scrap process.

The difference is perceived through an equipment that has automatic internal temperature control and adjustment through air conditioners. The amount of tailings of the same parameters in the same time period were only 7 tailings. The difference is huge, which justifies the efficiency of the second example by the low amount of tailings for the same problem.

The investment for the deployment of air conditioners in equipment that did not have temperature control would be $ 20,000 dollars, however, given the current costs with problems related to the weldpaste, it would take about a year and nine months for the investment to be paid. What in 10 years would be a profit of $112,560 dollars.

IV. FINAL CONSIDERATIONS

Therefore, in view of the results obtained, it is possible to conclude that the equipment that has internal temperature control has a higher efficiency than the equipment that does not have to improve the production process as a whole, because it is one of the first steps. Therefore, the application of this concept leads any company that is part of the SMT sector to obtain satisfactory results for the company and for customers in order to produce with more quality, productivity and effectiveness.

The study of the weld paste is comprehensive, which allows to improve the techniques presented here, and if replication is properly analyzed for any company that wants to have an efficient production process in order to satisfy the company as a whole and the end customer that is the focus of the production performed, generating positive results for all involved.

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