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JETTING SOLDER PASTE OPENS UP NEW POSSIBILITIES IN YOUR SMT PRODUCTION

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ABSTRACT:
Jetting of liquids is becoming the standard in our industry. MYDATA has developed a unique tool to jet solder paste. This non-contact method of applying solder paste has a large number of advantages compared to standard screen printing or dispensing. The challenges of today's production environment is not only the fact that components getting smaller but the biggest challenge is the combination of small and large components on the same board. Putting the right amount of solder paste for each component will be required to deliver the right quality. Depending on the volume requirements Jet Printing can be an alternative tool to cope with this mix or be used as an add on tool to compliment the screen printer in a high volume environment.

The Jet Printing technology allows to build up the volume by single dots to achieve the right amount for each component. Special applications like pin in paste, applying paste in cavities and many more challenges of today's requirement can be easily accommodated with this technology.

Mixing different types of solder paste with different metal content will be discussed as typically jet printing paste is type 5 versus type 3 or 4 for a screen printer.
The differences between jet printing en dispensing will be highlighted and technical challenges with broad band technology will be discussed.

Keywords: Jet Printing, Broadband Technology, Solder Paste, Jetting

INTRODUCTION:
Jetting technology came to the SMT industry about 15 years ago. Before it came to the SMT industry it was already used in many areas of which the printing area is the most known. Everybody had seen an ink jet printer at that stage. However only low viscous materials where being jetted which limited the possibilities in our applications for the SMT industry. The first material that was commercially jetted in the industry was an SMA which was much higher in viscosity than the traditional inks that were jetted before. There were a lot of reasons people wanted to have an alternative for traditional dispensing. The traditional dispensing process had too many variables and the speed was not keeping up with the industry demand. Also people wanted to have a more stable process with less operator interference. Since then a lot has changed and jetting has become the standard in our industry. More and more people have realized the advantages of non-contact jetting versus dispensing. A major breakthrough in the SMT industry was established when in 2006 the first jet printer that could handle solder paste was presented.

WHAT IS THE MAIN DIFFERENCE BETWEEN JETTING AND DISPENSING:
Jetting is the process in which fluid is ejected rapidly through a nozzle, using the fluid momentum to break free from the nozzle. A certain volume of material is ejected with each jetting cycle. The fact that it is a non-contact way to apply fluid is key. Typical jetting frequencies are 100– 200 Hz, but can be as high as 1000 Hz for short periods. The MYDATA Jet printer has developed a unique SW that allows to trigger the Jet while moving above the PCB. This typically can achieve dot rate speeds as high as 1.000.000 dots per hour. A Dispenser typically can achieve a much lower dispense rate.

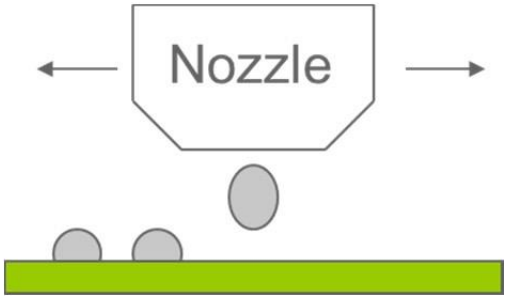


Figure 1. Non-contact way to apply solder paste Up to 1.000.000 dots/hour, dot sizes between 5-15 nl

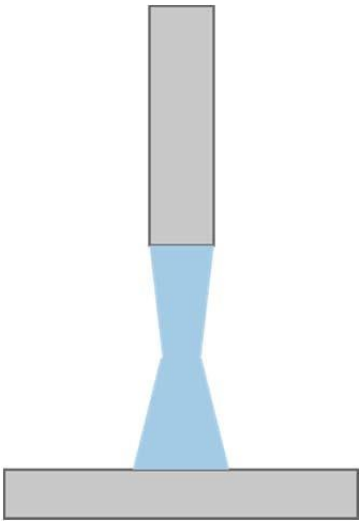


Figure 2. Jetting vs. Needle Dispensing Dot formation when dispensing.Pulling a needle out of a "pool" of fluid will form a column that will eventually break into 2 or more pieces. Fluid needs to make contact with substrate in order to break off.

There are several differences between jetting and needle dispensing. When fluid is ejected from the jet nozzle, it detaches from the nozzle tip before contacting the substrate. Fluid is delivered in certain volumes on the substrate to form individual dots, or combined to form lines or patterns. When moving from one dispense location to the next, it is not necessary to move the Z-axis, which saves a considerable amount of time. With needle dispensing, fluid remains attached to the needle tip and substrate surface, while the robot mechanics traverse in the X, Y, and Z axes. Gravity and surface tension of the substrate are used to pull fluid away from the needle. After each dispense segment or dot, a distinct Z-axis movement must occur before moving to the next dispense location.

Typical challenges with dispensing

In order to achieve a good and repeatable result you need to control many parameters in a dispensing process. Main parameters for the operator to take into considerations are:

- Amount of material
- Needle dispense gap
- Needle size
- Dwell time
- Retract speed
- Material characteristics
- Air pressure
- Temperature

ADVANTAGES OF JETTING SOLDER PASTE:

This non-contact method of applying solder paste has a large number of advantages compared to standard screen printing or dispensing. The challenges of today's production environment is not only the fact that components getting smaller but the biggest challenge is the combination of small and large components on the same board. Putting the right amount of solder paste for each component will be required to deliver the right quality. The jet printing technology allows to build up the volume by single dots to achieve the right amount for each component. The technology is not limited to one stencil thickness but can make 3D (Fig 3) deposits which can help with typical problems as bill boarding, solder balling or can ensure a good heel fillet.

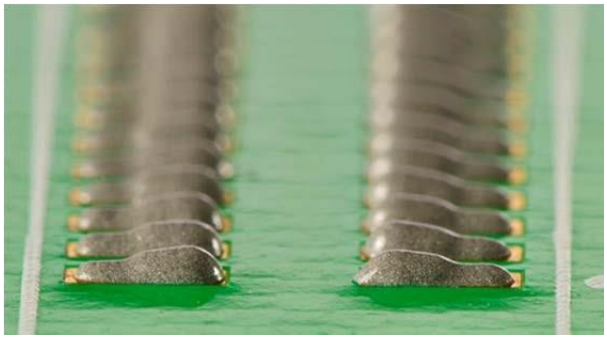
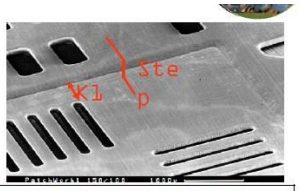


Figure 3. 3D Deposit to ensure a good heel fillet

Since the jetting technology is building up the volumes by single dots it also enables small deposits next to large deposits with no limitations of the keep out area's which you will have if you would use a stepped stencil. Below you will find a chart (Fig 4) with IPC design rules for stepped stencils and keep out zones related to the step you would like to make. In many cases the design people have not always taken these rules in considerations with all consequences for the production people in the SMT shop.

IPC 7525 stencil guidelines

As a general design guide K1 should be 0,9mm [35,4mil] for every 0,025mm[0,98mil] of step- down thickness.



Step in mm	K1 is distance form the step edge to the nearest aperture in step -down area
0,010 [0,397mil]	0,36mm [14,1mil]
0,020 [0,787mil]	0,72mm [28,3mil]
0,025 [0,984mil]	0,90mm [35,4mil]
0,030 [1,181mil]	1,08mm [42,5mil]
0,050 [1,969mil]	1,80mm [70,9mil]
0,080 [3,14 mil]	2,88mm [113,4mil]
0,100 [3,937mil]	3,60mm [141,7mil]

Figure 4. IPC 7525 stencil guidelines

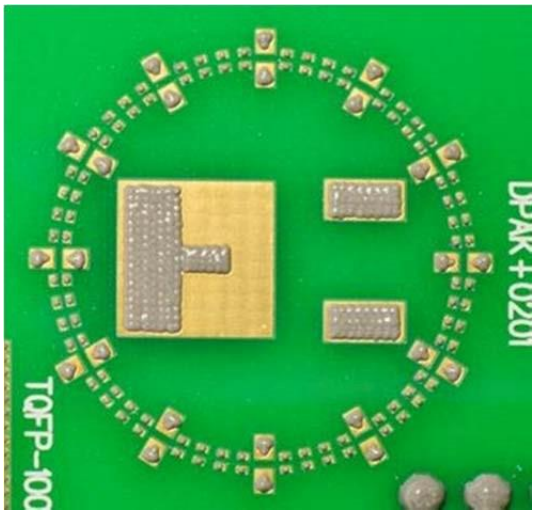


Figure 5. Mix of small (0201) and large (D-pack) components in close proximity

Another typical problem you can find in an SMT production shops is lack of solder deposit because a via hole is draining the solder from the pad (Fig 6). This typically is causing rework and quality issues. It is very difficult and sometimes impossible to correct this with a stencil design change. Since the jet printing technology is fully software driven the possibilities are unlimited and typically a solder deposit pattern can be created to ensure there will still be enough solder on the pad to make a good connection.

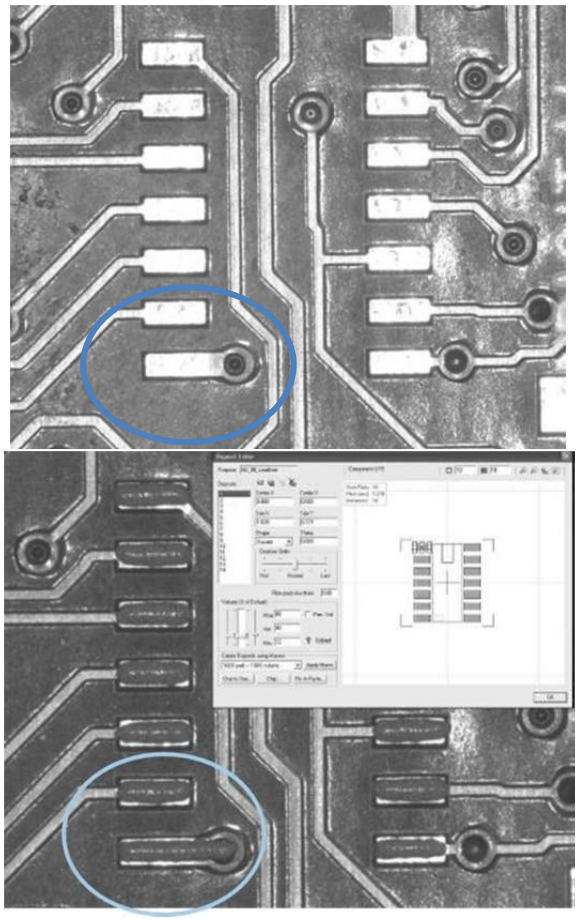


Figure 6: Solder Paste drainage through via hole

ADD-ON JET PRINTING:

So far we have been comparing the jet printing technology with dispensers and screen printers. We have discussed the differences and the specific advantages. Typically the jet printing technology has been competing with screen printers in the low to mid volume segment. In that particular segment jet printing has gained a lot of momentum as the benefits of fast changeovers, no more stencil investments and a lot more uptime of the line has convinced a lot of low to medium volume manufacturers already today. In high volume lines where tact times can be as short as 15 seconds the screen printer still is the preferred choice. However with the new technology trends, broadband (mixing small and large components) it becomes very hard to deliver the right amount of solder in one go with a screen printer. In mobile phone applications where a lot of 01005 components are being used typical stencil thickness are less than 100 micron which can be challenging if you have connectors or shielding that require more paste. With the typical density of the boards a stepped stencils is not an option neither. Therefore an additional add on step is implemented to add extra volume for the shielding or certain connectors. Here Jet Printing again can be a good solution as shown in the (fig 7). A screen printer will apply the solder and the jet printer will add solder for those components that need more

or it will solve the difficult area's where you need to put solder deposits in cavities. Industry trends confirm this as more and more screen printers are being equipped with dispensers to overcome these problems. However if high speed is required it will slow down the screen printing process so that the requested cycle times are no longer met.

Figure 7. Add on paste for components that require more volume or add paste in cavities that are too big for a stepped stencil to reach

One of the questions is what happens if you start to mix different types of paste with each other. All the current paste approved for jet printing applications are type 5. Most commonly used pastes types today are type 3 or type 4 paste. Will mixing a type 5 with a type 3 or 4 cause any issues. This might vary off course of the paste specifics but tests at a major OEM have shown that mixing there current pastes with jet printing pastes have been fully passed all qualification tests. Another test was done at one of our paste suppliers (Alpha) and there we tested a number of commonly used pastes together with their qualified jet printing paste called JP500. Again there we got confirmation that mixing the jet printing paste with screen printing paste was passing all their typical quality tests. This gives us a good indication that mixing of different types of paste for an add-on process is a feasible option.

CONCLUSION:

Over the years jetting has gained importance and has become the standard in the industry to apply fluids. A non-contact way has many advantages over a traditional dispensing process. Jet Printing of solder paste can be used in low to mid volume segments to replace a screen printer but can also be added in high volume lines to take care of the challenging deposits or to add solder paste where needed. Today Jet Printing is no longer seen as a futuristic technology but it has proven itself and the technology is still gaining momentum. With all the developments going on it looks like Jet Printing will increase further the coming years.