

Air Powered Dispensing of Solder Paste

Abstract

In this white paper, Nordson EFD explains the most critical variables affecting air-powered dispensing of solder pastes and outlines how to manage those variables to your advantage. Key variables include:

- Solder Paste
- Dispense Tip Type
- Air Pressure
- Dispense Cycle Duration
- Fluid Temperature
- Fixturing
- Fluid Reservoir Size

Introduction

Air-powered dispensing systems use controlled pulses of air pressure to dispense solder paste from syringe barrels in uniform amounts.

Air-powered dispensing equipment comes in many shapes and sizes. Each and every unit has at least two

characteristics in common with all the rest: air pressure regulation and dispense cycle control.

Compared to the use of wire solder and solder preforms, dispensing solder paste with an air-powered system is a relatively simple and much more flexible option. One would think that with only two machine variables needed to control dispensing, air-powered application of solder paste would be foolproof, but this is not always the case.

Each section of this white paper addresses a process variable and provides an explanation of successful and unsuccessful implementation for each.

Solder Paste

Solder paste is a mixture of spherical solder alloy particles (called “solder powder”) and a gel-like flux medium. The flux medium coats all the particles to protect them from oxidation and holds them in suspension.

When pressure is applied to solder paste, it is actually applied to the flux medium that contains all the solder powder. The flux medium picks up and carries the solder powder, as the flux medium is put into motion.

The better the flux medium, the shorter the delay between when the flux and the solder powder start to move. This characteristic determines both how well the solder paste dispenses and the rate at which the flux medium can separate from the solder powder.



Air-powered dispensers provide the best performance when used to produce solder paste deposits between 3 milligrams and 0.50 grams.

Dispense Tip Type

For every dispensing application, there is an optimal dispense tip style and size. The trick is to identify which one is the best for your process.

When choosing a tip, do not expect to produce a deposit with a diameter smaller than 1½ times the ID of the tip. Although it is technically possible to produce smaller deposits, it is very difficult to do so in a real-world environment.

As a rule, you should use the least restrictive dispense tip that will meet your deposit size requirements. Larger gauge tips allow for faster flow and produce less flow restriction on the solder paste during the dispense cycle. Shorter cannula steel tips have less flow resistance than longer ones. Tapered tips produce less flow restriction than straight-walled tips. Rigid tapered tips, as opposed to the more flexible regular tapered tips, resist deformation and produce more consistent deposits.

A dispense tip that is too restrictive for the type of paste in use will cause excessive back pressure and tend to result in tip clogging.



1/4" general purpose
stainless steel tip

1/2" general purpose
stainless steel tip

Tapered tip

Longer tips are useful for reaching out-of-the-way deposit locations. Paste will dispense more slowly from a smaller tip, allowing smaller increments in deposit size per unit of time.

These effects may be used to meet tight deposit size tolerances by combining a more restrictive tip with a longer cycle time. In any case, tip choice can make or break a dispensing process and is a critical part of optimizing your dispensing results.



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Air Pressure

With air-powered dispensing systems, air is used to transmit force to the material being dispensed. Choosing a pressure setting for an application requires an understanding of how solder paste reacts when put under pressure.

Apply too little force, and the material will not dispense fast enough or not at all. Apply too much force, and the

flux is forced out of the paste—a phenomenon referred to as “separation.”

For most solder paste dispensing applications, a pressure range of 20 psi to 40 psi is appropriate, but this is not a hard and fast rule. Higher or lower pressure may be required, depending upon tip type, package type, and solder paste formulation.

Start out in the 20psi to 40psi range. If you think you need higher or lower pressure to reach your process goals, consult your solder paste manufacturer to help identify possible alternatives.

Dispense Cycle Duration

The length of the dispense cycle determines how much material is dispensed for any combination of pressure and tip type. Problems related to dispense cycle duration arise only when the cycle is too short. It is almost always possible to avoid “too short” pulse durations, and it is useful to know why. During each pressure cycle, the system undergoes a series of six ordered steps:

- 1) The air hose and empty volume of the syringe barrel are pressurized.
- 2) The flux is pressurized and begins moving towards the syringe barrel exit.
- 3) The accelerating flux overcomes the resistance in the system, picking up and carrying the solder powder as it moves.
- 4) The paste shear thins (viscosity drops) as it accelerates until achieving a steady flow state.
- 5) Pressure is removed and the solder paste decelerates to a stop.
- 6) Over time it thickens back to the pre-shear thin viscosity.

Note: If the dispenser has a barrel vacuum feature, it should be turned off when dispensing solder paste.

Keep in mind that there is a minimum time required to execute each step. This time is influenced strongly by the tip type and the amount of material in the syringe barrel. The lower the flow resistance of the dispense tip, the shorter the time required to reach Step 4. The time requirement also changes as the syringe empties, lengthening in relation to the increasing volume of air requiring pressurization.

For each solder paste formulation there is a minimum cycle time. When cycle time is shorter than the minimum, the process will barely reach Step 3, and a steady flow state will not be achieved.

Combined with the shock produced by high pressure, short cycle duration can degrade paste beyond the point of dispensability.

Fluid Temperature

The effects of temperature on solder paste dispensing are generic to most dispense methodologies. Dispensed air is not an exception. As temperature changes, three things happen:

1) The paste changes viscosity.

Increases in temperature soften components in the paste making it thinner and less viscous. Decreases in temperature have the inverse effect, thickening the paste.

Note: Above 27° C (80° F), softening can reach the point at which the paste loses the ability to hold the solder alloy in suspension, resulting in paste separation.

2) Deposit size varies as the temperature varies.

Changes in viscosity affect flow rate and, therefore, deposit size produced with a particular set of dispense settings. Keep temperature variation to a minimum as a safeguard against temperature-related deposit size variation.

3) The flux chemistry reaction rate accelerates with increased temperature.

The flux is active to some extent even at low storage temperatures. At temperatures above 27° C (80° F) the reaction rate is noticeably faster.

Unless a temperature control system is used, paste temperature is increased by both environmental conditions such as room temperature and localized heat sources as well as the conversion of kinetic energy to heat through friction as the dispenser cycles.

There are several temperature control systems available for industrial dispensing applications; some heat the material at the valve nozzle, and others heat the material within a specially-adapted barrel heater.

Fixturing

Often overlooked as either a process design consideration or possible cause for problems, syringe fixturing can play a pivotal role. The operating life of dispensable solder paste can be drastically reduced by poor fixturing practices.

The single most frequent fixturing mistake is placement of dispense equipment relative to a heat source used for reflow. Close proximity to heating units can result in elevated solder paste temperatures with attendant

effects. Temperature control equipment, shielding and improved airflow can be used to minimize or eliminate such heating affects when close proximity is required.

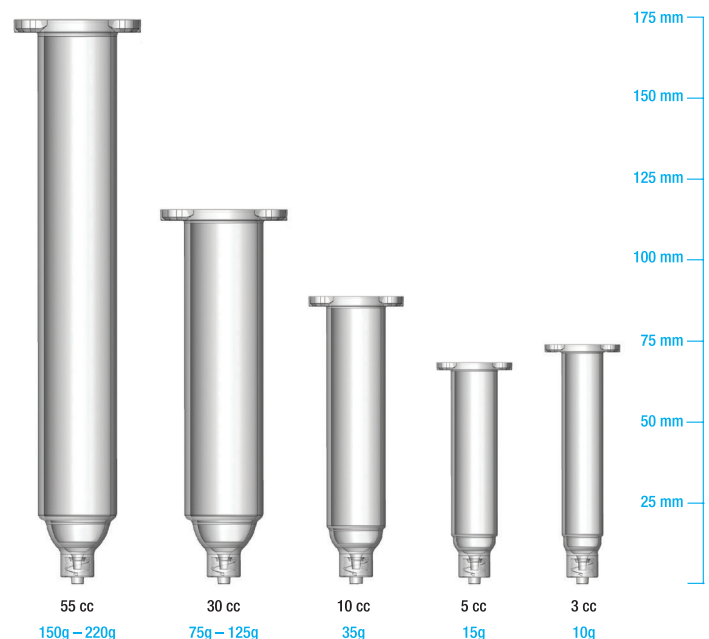
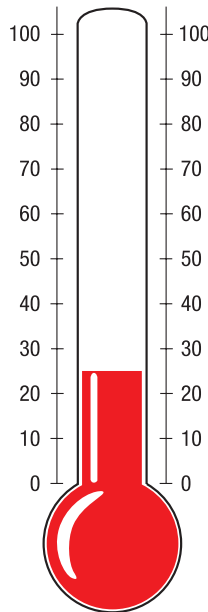
Physical stress applied to solder paste in the forms of shaking, sharp impacts, and vibration all have degradation effects. The worst of the three is vibration. Equipment that generates strong vibrations, such as vibratory bowl feeders, should be isolated from dispense machinery to avoid rapid paste separation. If the dispense machinery cannot be isolated, smaller syringe barrels can be used to match the volume used to the exposure limit imposed by the vibration source.

Fluid Reservoir Size

Selecting a syringe barrel size is a compromise between replacement frequency, temperature, and deposit size.

For example, in applications where solder is consumed at the rate of 10 grams an hour, 3cc syringes would not be a good choice, because they would have to be replaced approximately every hour. For this application, a 30cc syringe containing between 75 and 125 grams of paste would minimize downtime for syringe replacement. However, if 10 grams were being consumed every two days, using a 3cc syringe would minimize the amount of material wasted because of environmental degradation.

At higher temperatures, the question to consider is how large a reservoir can be used without subjecting an excessive amount of material to environmental degradation.



Sample syringe barrel sizes with corresponding volume of fluid

The size of the deposit determines the number of pressure cycles it takes to empty a given syringe barrel size. When making smaller deposits, it will take more cycles to empty the barrel, so paste is subjected to agitation (which degrades paste) for a longer time. When making larger deposits, fewer cycles are needed to empty the barrels and cartridges, and there is less risk of paste degradation.

Conclusion

Because they are capable of producing such a wide range of deposit sizes, air-powered dispensing systems are the ideal tool for applying solder paste in many different operations.

Request Information

Nordson EFD's worldwide network of experienced solder paste specialists are available to discuss your dispensing project and recommend a system that meets your technical requirements and budget.

Call or email us for a consultation.

800-556-3484

info@nordsonefd.com

www.nordsonefd.com/recommendations

Connect with us



Air-powered dispensers provide the best performance when used to produce solder paste deposits between 3 milligrams and 0.50 grams. Size-wise, this amounts to deposits between 1 and 10 millimeters in diameter under most conditions.

Solder Paste Dispensing for Higher Throughput

Automated dispensing systems using pneumatic jet valves or dispense valves are another option for applying solder pastes, especially in applications that require faster cycle time and higher throughput. Contact your EFD application specialist for details.



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