ELECTRONIC ASSEMBLY MISPRINT CLEANING ADVANCEMENTS

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ABSTRACT:

Assemblers surveyed report that cleaning misprinted circuit assemblies is a production gap that has not been adequately addressed. Traditionally, the industry has used stencil cleaning agents and equipment to address this rework need. One of the benefits of cleaning misprinted assemblies with the stencil cleaning process is the ability to collect and filter wet solder paste. The major short coming of cleaning misprints within stencil cleaning processes is the inability to remove B-side reflow flux residues from both the surface and under bottom termination components.

The purpose of this research is to test and validate new cleaning equipment innovations that allow for misprints to be cleaned from electronic assembly batch and inline production cleaning equipment. Cleaning misprints within production spray-in-air cleaning equipment has been looked down upon due to wet solder paste accumulating within the wash tank. Free solder spheres that are picked up by the pump can be wedged and deposited onto production assemblies. Recent cleaning equipment innovations have been developed to trap, collect and filter wet paste removed from misprints. Designed experiments will be run to test the robustness of the process and validate cleaning of both wet solder paste and reflowed flux residues.

KEY WORDS

Electronic Assembly Cleaning, Stencil Printing, Misprint Rework, Batch Cleaning Machines, Inline Cleaning Machines, B-Side Misprint Cleaning

REWORKING/CLEANING MISPRINTED ASSEMBLIES

Stencil printing is a highly automated process. During machine setup, a small group of boards are misprinted. During production stencil printing, circuit boards are periodically misprinted due to clogged apertures, stencil out of alignment, solder paste rheology shifts and other issues. Stencil misprints are defined as A-Side (Initial print out of alignment with no components previously placed) and B-Side (A-Side was successfully printed and components placed and soldered. The subsequent process of printing the B-Side results in the solder paste being out of alignment resulting in a B-Side misprint).

Printed Circuit Board misprints are a costly problem with no easy rework methodology. Production cleaning processes are normally not used to clean misprint assemblies. Potential quality issues such as:

- Solder balls collecting into the wash tank and being transferred back onto the assembly
- Solder balls migrating into the rinse streams resulting in hazardous waste from metals in the wash and rinse holding tanks

These complexities potentially compromise repeatability and reliability standards. Due to these complex issues, most assembly houses do not allow misprints to be cleaned within their production cleaning process.

Assemblers commonly address the misprint cleaning need by either hand wiping the misprinted side of the circuit card and/or clean the misprint in a stencil cleaning machine. Both methods create the potential for quality issues. First, when wiping solder paste from the misprinted side of the board, solder paste can be trapped in solder mask defined channels, through-hole vias, and other board geometries (Figure 1). Numerous quality problems can result due to lack of control and definition.

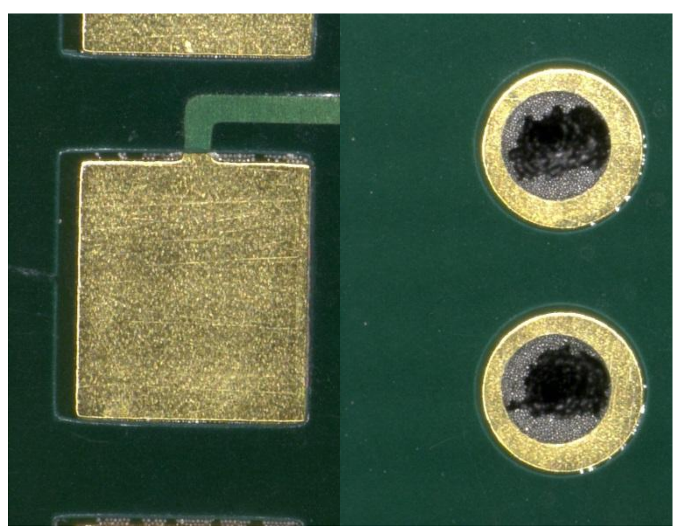

Figure 1: Solder Balls Wedged into No Solder Mask Defined Channels and Via Holes

Second, stencil cleaning machines are designed to remove wet solder paste from stencils. Most stencil cleaning processes do not rinse the stencil with water. For those that use a water rinse, the water is reused since trace levels of metals in water prevent disposal to local treatment works. Cleaning a production board in a machine designed to clean stencils fails to meet ionic cleanliness standards required for a production assembly. Additionally, on B-Side misprints, the stencil cleaning agent is typically not adequate for cleaning reflowed flux residues on the A-Side of the board. In most cases, the stencil cleaning agent partially removes the reflowed no-clean flux residue resulting in white residue and an ionically dirty assembly.

MISPRINT CLEANING INNOVATIONS

Cleaning the misprinted circuit board within an electronic assembly production cleaning process has the potential to achieve cleaning of wet solder paste and reflowed flux residues as well as meet quality and yield objectives. The problem with cleaning a misprinted circuit board in a production cleaning process is the deposits of solder spheres collected into the wash holding tank. Free solder spheres within the wash holding tank can be picked up by the inlet of the pump and sprayed onto production assemblies. There is also the potential that the solder spheres can be dragged into the rinse sections. Both quality and waste treatment issues result from this practice.

To resolve the quality and water treatment issues, a leading manufacturer of electronic assembly cleaning tools designed an innovative collection and filtration method to collect and filter solder spheres. The invention is offered on both batch and inline electronic assembly production cleaning machines. The misprint cleaning design contains the solder spheres and captures them to prevent spraying solder balls through the pump and spray manifolds. The mechanical and filtration systems resolve the issues of redepositing solder balls onto production assemblies and the potential to contaminate rinse streams. The overriding quality advantages in systems that are designed for repeatedly removing all solder spheres from the assembly, remove reflowed flux residues and render an ionically clean printed circuit board provide a reproducible and repeatable product.

Electronic Assembly Inline Misprint Cleaning Design

A misprint option was developed to clean boards misprinted with raw solder paste through a production inline aqueous printed circuit board assembly cleaning machine (Figure 2). The pre-wash section of the cleaning machine is designed to wet, elevate the circuit board to wash temperature, and soften reflowed flux residues from production circuit assemblies. The flux composition within raw solder paste cleans easier than does reflowed flux residues. An S-Jet™ spray nozzle design is used within the pre-wash section to displace greater than 90% of the solder paste on a misprint circuit board.

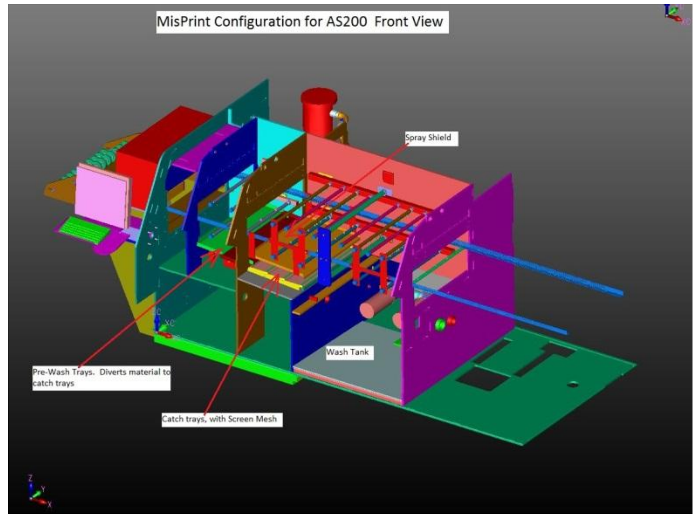

Figure 2: Front View of the Wash Section

The pre-wash section is equipped with deflectors that contain the raw solder paste as it is being displaced from the circuit assembly. The deflectors close in the pre-wash spray manifolds using two trays and plates to prevent solder spheres from escaping the housing of the pre-wash section (Figures 3/4). As the boards enter the pre-wash section, the displaced solder balls and wash fluid drain into the catch trays. By capturing and containing the pre-wash liquid, the majority of the solder balls can be channeled into a series of sluice boxes. This important design feature contains the bulk of the solder balls with a minimal amount escaping to the wash holding tank.

Figure 3: Pre-Wash Containment Design

Figure 4: Pre-Wash Containment with Side Cover Removed

A series of Sluice Boxes are designed to capture the heavy raw solder spheres similar to the techniques used in mining precious metals from water streams (Figure 5). Three separate sluice boxes capture the majority of the solder paste. Each sluice box is equipped with a wire mesh. The weight of the solder balls drop through the wire mesh and collect into the sluice box trays. The first sluice box captures the majority of the solder spheres with the remaining two sluice boxes used to collect the residual solder spheres.

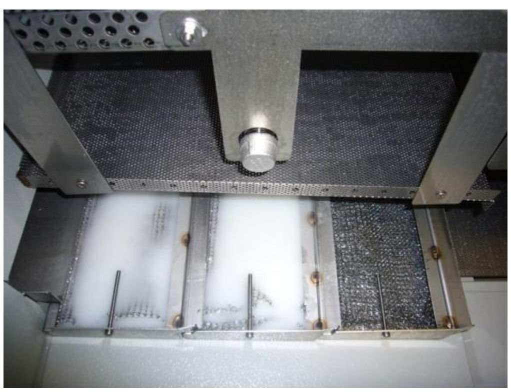

Figure 5: Sluice Box Collection Boxes

Solder balls that are not collected within the sluice boxes will drain into the wash fluid holding tank. To prevent these stray solder balls from being sprayed onto circuit boards, three pump intake strainers prevent large spheres from entering the pump (Figure 6). The smaller solder spheres that pass through the strainers will be captured in a bag filter from wash liquid pumped through the outlet of the pump.

Figure 6: Strainers in Suction Inlet of the Wash Holding Tank

Following the suction strainers, the wash solution is pumped through a filtration system designed to collect any remaining solder spheres before reaching the spray manifolds (Figure 7). The wash outlet enters the top side of the filtration canister, exits the clean side of the filter and then goes to the spray jets.

Figure 7: Filtration Canister

Within the canister, there are internal bars that prevent the bag filter from getting next to the exit side of the filter housing (Figure 8). This design feature prevents back flow or resistance as the liquid pumps through the filter canister. The 10/5 bag filter cartridge (ten microns on the inside and 5 microns on the outside of the filter cartridge) provides double redundancy to contain any solder balls from escaping the filter (Figure 9). The 10 micron side captures the heavy particles and the fine 5 micron side of the filter assures no solder spheres are sprayed onto circuit cards. The filtration design removes solder balls as small as Type 5 Solder Paste while preventing solder balls going to the manifolds (Figure 10). Pressure drops are minimal due to the solder paste being captured within the bag filter. Should the pressure drop, the machine is equipped with a user defined interface, which sends an alarm to the operator. The design is such that thousands of misprint boards could be cleaned before having an impact on the bath integrity, pressure and cleaning performance.

Figure 8: Internal Filter Support Housing

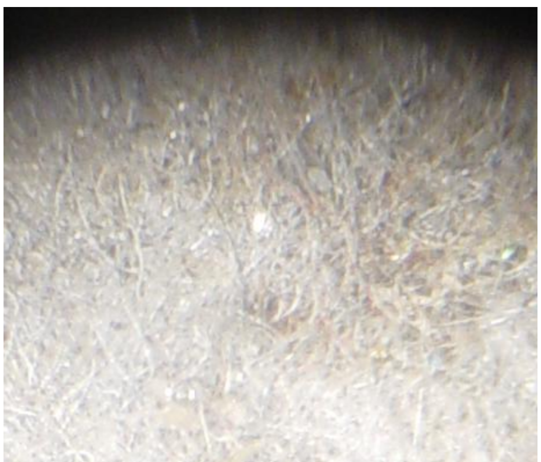

Figure 9: Solder Spheres Captured in 5 Micron Bag Filter

Figure 10: Filter Cartridges

The cutaway CD view of the rear side of the cleaner provides an overview of the wash tank, triple strainers, pump housing and filtration. The D.O.E. will test both the ability capture, filter and clean misprinted circuit boards (Figure 11).

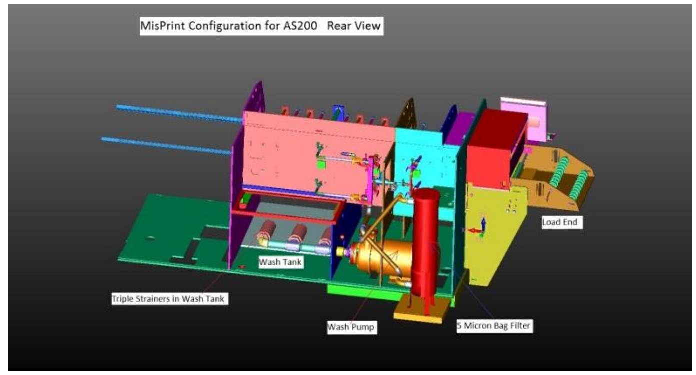

Figure 11: Rear View of the Misprint Configuration

Electronic Assembly Batch Misprint Cleaning Design

One main difference between batch cleaning machines versus an in-line type cleaner is the ability to program the type of wash cycle, the sequence, and cycle times within the cleaning process. It is therefore critical that the ability to effectively trap and collect wet solder paste be integrated into the batch cleaner wash cycles.

The design objective is to provide the board assembler the flexibility to deflux their normal production runs (A/ B side), deflux an A-side with B-side misprint, clean A/B side misprint, plus the ability to completely rinse and dry the product within the same batch type cleaner.

Similar to the design for the in-line cleaning system, the same equipment manufacturer used the multi-stage filtration approach to effectively collect solder spheres and to prevent the spheres from being sprayed onto the board assembly. A pre-wash type cycle in the batch cleaning process will wet, elevate the circuit board to wash temperature, and soften the reflowed flux residues from the production circuit assemblies. The flux composition with the raw solder paste is easier to remove than the reflowed paste. An internal bag type filter is used to capture the raw solder paste that is removed during the Flood Wash cycle (Figure 12). The main purpose of the internal bag filter is to minimize the amount of solder paste that would be drained into the wash fluid holding tank.

Figure 12: Bag Filter in Wash Holding Tank

Solder spheres that are not collected in the bag filter will collect in the wash fluid holding tank. To prevent large particles from entering into the wash pumps, two intake strainers are located in the wash holding tank (Figure 13).

Figure 13: Batch Intake Strainers

Following the suction strainers, the wash solution is pumped through a filtration system that is designed to capture the smallest of solder spheres before being sprayed through the wash fluid spray delivery system. The filtration system is designed to capture solder paste as low as type 5 paste (Figure 14).

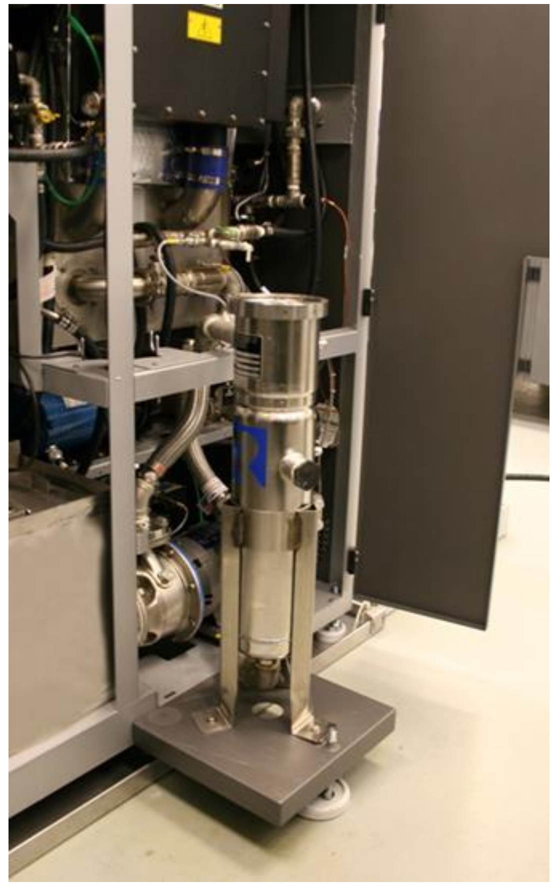

Figure 14: Batch Filtration Design

METHODOLOGY

Designed Experiment #1: Inline Cleaning Machine

The objective of the first designed experiment was to determine if solder spheres were present in wash liquid exiting the spray jets (Table 1). A total of 1000 grams of solder paste was washed off boards and collected into the wash section. Two lead-free solder pastes were selected, one being no-clean and the second being water soluble. 100 gram additions of the lead-free and water soluble were added for a total of 200 grams of solder paste per test condition (Figure 15). After each 200 gram addition, the wash section was sampled at the outlet of the spray manifold. Five additions were made for a total of 1000 grams of solder paste. The samples were sent to a chemical lab to run Millipore Filtration and Non-Volatile Residue tests. If solder spheres were present, they would be detected using the Millipore test. The flux solids would be detected using the Non-Volatile Residue test.

Millipore test is used to determine if solder spheres are present in wash liquid that is sprayed onto circuit assemblies as they are being cleaned. The solution was filtered using 1 micron filter paper. The weight of the filter paper was measured. Following filtration of the wash sample, the filter pad was placed in an oven to dry. The dried filter paper was weighed following the drying process. The total weight in grams minus the tare weight in grams equals the weight of solder spheres present in the wash solution.

Non-Volatile Residue test is used to quantify the level of non-volatile residue in a wash liquid sample. A portion of the sample is placed into an aluminum weighing dish at 120°C for a minimum of one (1) hour. The residue is allowed to cool in a desiccator and weighted. The weight of the residue is compared to a virgin sample of the wash solution.

Addition	Solder Paste	Test Vehicle	Solder Paste Addition
1	Indium 8.9 LF - No Clean	Plain FR4 Board 8"x8"	100 grams
1	FCT WS888 (SN100C)	Plain FR4 Board 8"x8"	100 grams
2	Indium 8.9 LF - No Clean	Plain FR4 Board 8"x8"	200 grams
2	FCT WS888 (SN100C)	Plain FR4 Board 8"x8"	200 grams
3	Indium 8.9 LF - No Clean	Plain FR4 Board 8"x8"	300 grams
3	FCT WS888 (SN100C)	Plain FR4 Board 8"x8"	300 grams
4	Indium 8.9 LF - No Clean	Plain FR4 Board 8"x8"	400 grams
4	FCT WS888 (SN100C)	Plain FR4 Board 8"x8"	400 grams
5	Indium 8.9 LF - No Clean	Plain FR4 Board 8"x8"	500 grams
5	FCT WS888 (SN100C)	Plain FR4 Board 8"x8"	500 grams

Table 1: Inline Raw Solder Paste Additions

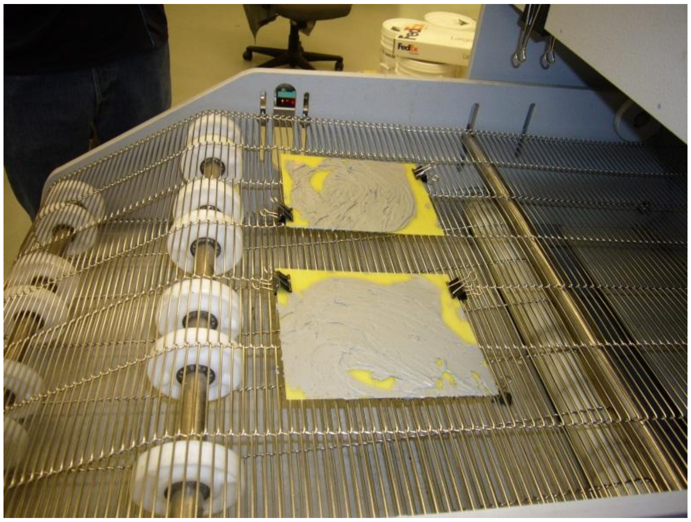

Figure 15: 200 grams of Solder Paste Added to Wash Section

Designed Experiment #1: Data Findings

The data findings are listed below in table 2 and Figure 16.

Sample ID	Solder Pastes Selected	Solder Paste Added	Solder Spheres greater than 0.22µm (g/100g)	NVR (%)
Control	None	0	0.00058666	0.227
Sample 1	Indium 8.9, FCTWS888	200	0.00046654	0.250
Sample 2	Indium 8.9, FCTWS888	400	0.003457833	0.263
Sample 3	Indium 8.9, FCTWS888	600	0.00132265	0.268
Sample 4	Indium 8.9, FCTWS888	800	0.001747419	0.283
Sample 5	Indium 8.9, FCTWS888	1000	0.07610376	0.311

Table 2: DOE 1 Data Findings

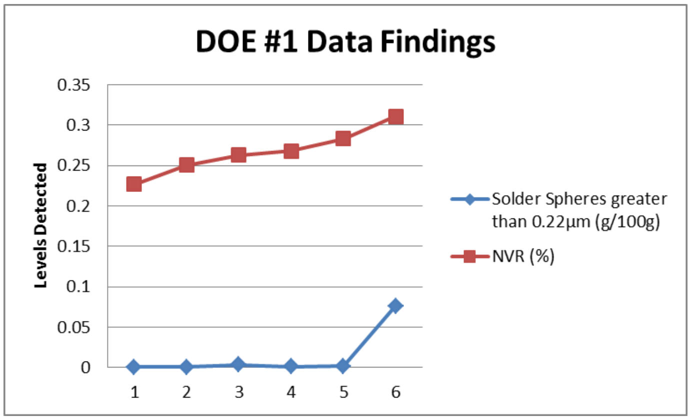

Figure 16: DOE#1 Data Findings Graphed

Designed Experiment #1: Inferences from Data Findings

The Millipore test was used to capture solder spheres that may be present in the wash bath samples. No detection of solder spheres was found up to 800 grams of solder paste added. At 1000 grams added to the wash bath, the levels found were very low at 0.07g/100gram. The data findings infer that very little to no solder balls are being sprayed onto boards being washed through the cleaning machine.

The NVR test tracked the non-volatile flux solids added to the wash solution. Roughly 0.02% flux solids were added to the wash bath per 200 grams of raw solder paste additions. The data findings infer that 0.02% flux solids would be accumulated into the wash tank per 200 grams of raw solder paste cleaned in the wash section.

The solder paste collected in the Sluice boxes were dried, collected and weighed (Figure 17). The three sluice boxes captured:

1. Sluice Box #1: 15 grams of solder spheres
2. Sluice Box #2: 95 grams of solder spheres
3. Sluice Box #3: 485 grams of solder spheres

The total weight of solder spheres captured in the sluice boxes was 655 grams. Roughly 80% of the 1000 grams of solder paste added represents solder alloys. The level of solder paste captured in the sluice boxes was roughly 82%.

Figure 17: Solder Paste Collected in Sluice Boxes

Designed Experiment #2: Batch Cleaning Machine

Unlike the inline cleaning machine design, the solder spheres from the batch cleaning machine are collected using a multi-stage filtration system. Double strainers are placed at the intake side of the power wash pump. Five micron bag filters are placed at the exit side of the flood and power wash pumps. A three hundred micron bag filter is placed at the drain back exit into the wash holding tank. The multi-stage filtration is designed to capture solder spheres and prevent them from being present in the wash fluid that is sprayed onto parts being cleaned.

The objective of the second designed experiment was to determine if solder spheres were present in wash liquid exiting the spray jets in the batch cleaning machine (Table 3). A total of 1000 grams of solder paste was washed off boards and collected into the wash section. Two lead-free solder pastes were selected, one being no-clean and the second being water soluble. One hundred gram additions of the lead-free and water soluble were added for a total of 200 grams of solder paste per test condition (Figure 18). After each 200 gram addition, the cleaner from the wash section was sampled at the outlet of the spray manifold. Five additions were made for a total of 1000 grams of solder paste. The samples were sent to a chemical lab to run Millipore Filtration and Non-Volatile Residue tests. If solder spheres were present, they would be detected using the Millipore test. The flux solids would be detected using the Non-Volatile Residue test.

Sample ID	Solder Pastes Selected	Test Vehicle	Solder Paste Added
Control	None	Plain FR4 Board 8"x8"	0
Sample 1	Indium 8.9, FCTWS888	Plain FR4 Board 8"x8"	200
Sample 2	Indium 8.9, FCTWS888	Plain FR4 Board 8"x8"	400
Sample 3	Indium 8.9, FCTWS888	Plain FR4 Board 8"x8"	600
Sample 4	Indium 8.9, FCTWS888	Plain FR4 Board 8"x8"	800
Sample 5	Indium 8.9, FCTWS888	Plain FR4 Board 8"x8"	1000

Table 3: Batch Raw Solder Paste Additions

Designed Experiment #2: Data Findings

The batch loading data findings are listed in Table 4 and graphed in Figure 18.

Sample ID	Solder Pastes Selected	Solder Paste Added	Solder Spheres greater than 0.22µm (g/100g)	NVR (%)
Control	None	0	0.000319957	0.307
Sample 1	Indium 8.9, FCTWS888	200	0.000893214	0.311
Sample 2	Indium 8.9, FCTWS888	400	0.00127982	0.321
Sample 3	Indium 8.9, FCTWS888	600	**0.02771**	0.315
Sample 4	Indium 8.9, FCTWS888	800	0.00121	0.312
Sample 5	Indium 8.9, FCTWS888	1000	0.0047187	0.331

Table 4: DOE #2 Data Findings

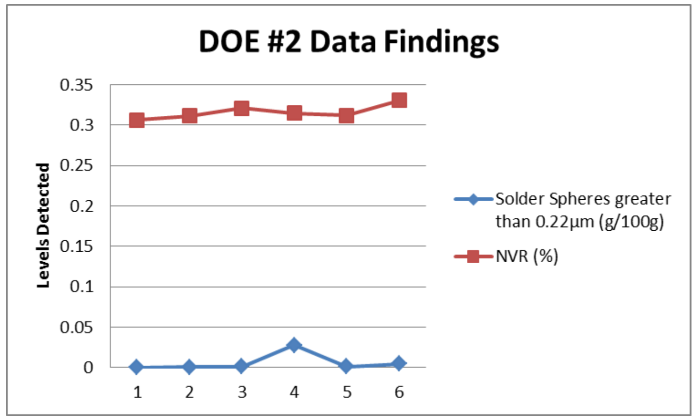

Figure 18: DOE #2 Data Findings Graphed

Designed Experiment #2: Inferences from Data Findings

The Millipore test was used to capture solder spheres that may be present in the wash bath samples. No detection of solder spheres was found from samples except sample #3. The level for sample #3 was 0.02g/100g indicating practically no breakthrough. Similar to the inline cleaning machine, the data findings infer that very little to no solder balls are being sprayed onto boards being washed through the batch cleaning machine.

The NVR test tracked the non-volatile flux solids added to the wash solution. For each 200 gram addition of raw solder paste, the range of flux solids added to the wash bath ranged from 0.005 – 0.02%.

At the completion of the test, the wash fluid was drained from the batch wash holding tank. A small amount of solder paste was collected at the bottom of the holding tank (Figure 19). The data findings infer that this small level of solder spheres on the bottom of the holding tank are successfully captured in the 5-micron filters on the exit side of the wash pumps.


Figure 19: Batch Wash Tank after Draining out Wash Fluid

Designed Experiment #3: A-Side Misprint Cleaning

The objective of DOE #3 was to test the effectiveness of removing miss-registered wet solder paste printed on two different board designs. The first board is designed with both large and small aperture component placements. The pad placements on the test board #1 were non solder mask defined (Figure 20).

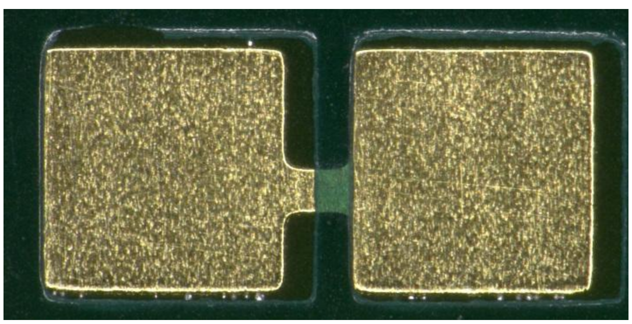
Figure 20: Non Solder Mask Defined Pads on Test Board #1

The second test board is an automotive design with larger pad placements. Many of the pads are solder mask defined. In absence of the troughs next to the pad, there is less risk of solder balls being wedged next to the pads (Figure 21).

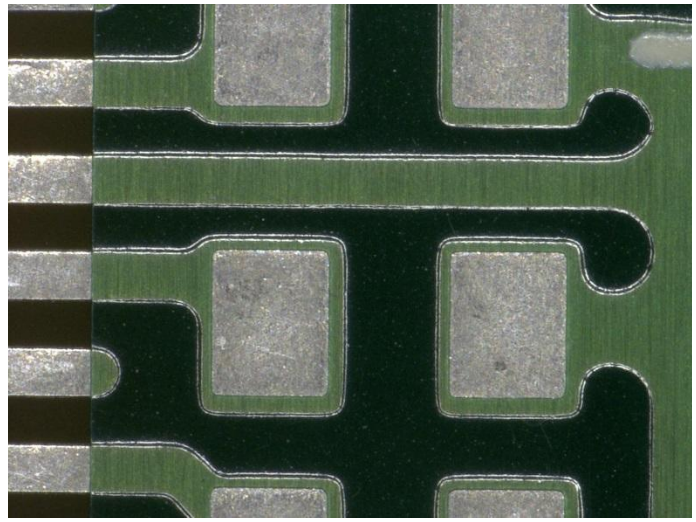
Figure 21: Solder Mask Defined Pads

The DOE factors and levels were as follows:

1. Test Board
   i. Non Solder Mask Defined Pads
   ii. Solder Mask Defined Pads

A unique feature with test board #1 is the offset of the solder mask defined pads. The solder mask removed around the pads is not uniform. In areas where the solder paste is tight to the pad, there is the potential for solder balls to become wedged (Figure 22).

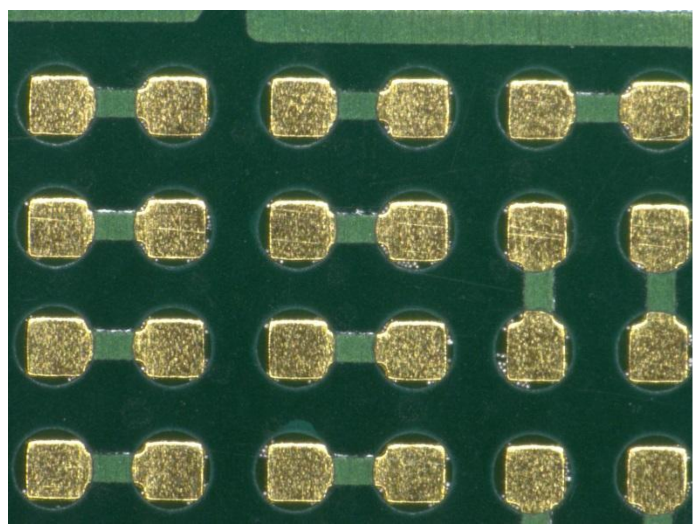
Figure 22: Wedging of Solder Balls

2. Stencil Printer
    i. Set to an offset so the board is misprinted

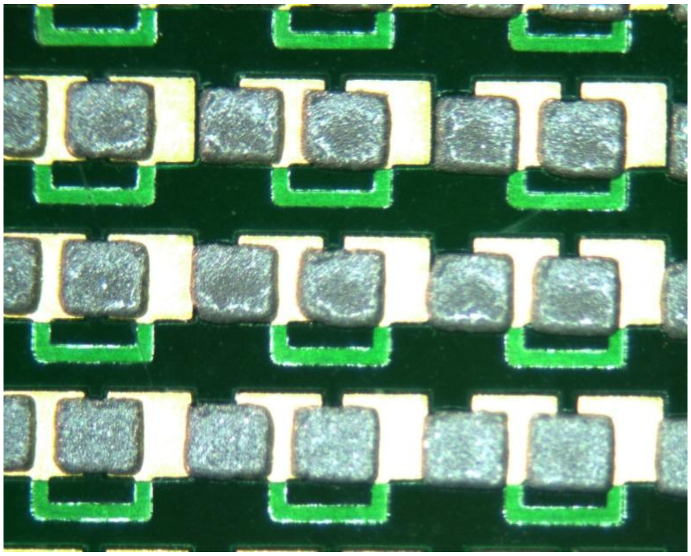

Figure 23: Misprint Example

3. Cleaning Machine
    i. Inline Spray-in-Air
    ii. Batch Spray-in-Air
4. Time from print to clean
    i. 1 hour
    ii. 2 hours
    iii. 4 hours
5. Cleaning Agent
    i. Engineered Aqueous #1
    ii. Engineered Aqueous #2
6. Wash Concentration
    i. 15%
7. Pre-Wash
    i. S-Jets for the inline
    ii. Flood wash for the batch
8. Wash
    i. Intermix of coherent and fan jets for inline
    ii. Power basket with coherent nozzles for batch
9. Wash Time
    i. Inline
        - 8 minutes
        - 4 minutes
        - 3 minutes
        - 2 minutes
        - 1.2 minutes
    ii. Batch
        - 15 minutes
        - 20 minutes
10. Wipe or No Wipe Before Cleaning
    i. Wipe
    ii. No Wipe

Many assemblers wipe the excess solder paste off the board before cleaning. The risk of wiping is the potential to wedge solder balls in the solder mask defined troughs and in the through-hole vias (Figure 24). Once a solder ball becomes wedged, it is highly difficult to un-wedge the solder ball. Even with high pressure spray impingement, solder balls wedged may not be able to displace and result in trace solder balls next to the pad. This factor may or may not be a problem. Due to this risk factor, best practice is to not wipe the board before cleaning.

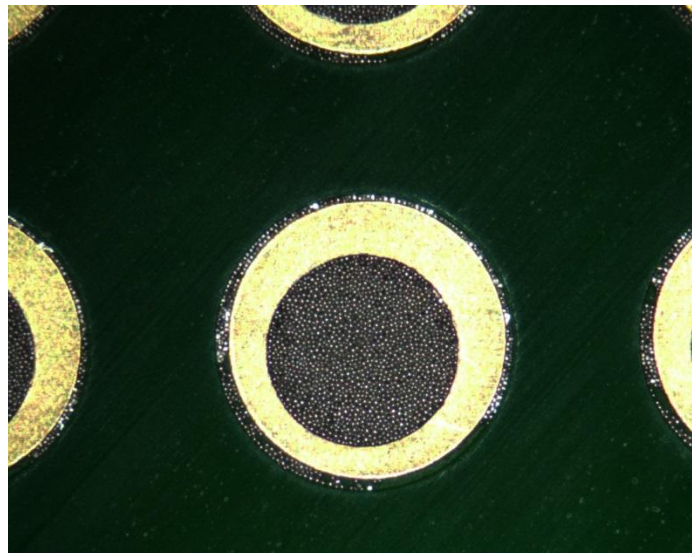

Figure 24: Wipe Before Cleaning is a Poor Practice and Not Recommended

Designed Experiment #3: Data Findings

The wet solder paste was consistently removed in both the batch and inline cleaning machines. Wash time and time from when the board was printed to the time it was cleaned did not factor into the ability to consistently remove the wet solder paste. Wash time and the time window from 1-4 hours after the misprint was not significant from a cleaning perspective.

The significant factors that impacted cleaning results were the inconsistency of the non-solder mask defined troughs and wiping before cleaning. Wiping the solder pads into tightly defined troughs wedges solder balls between the board and the pad. Solder balls that are wedged do not always release during the cleaning process (Figure 25).

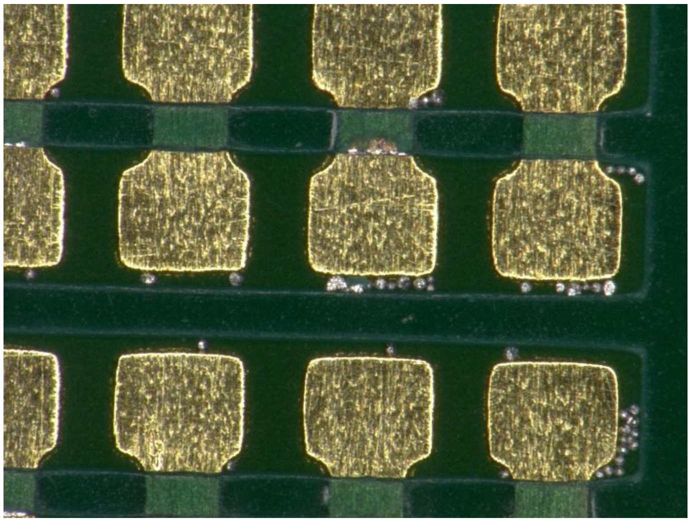

Figure 25: Solder Balls Wedged Due to Wiping Before Cleaning

Designed Experiment #3: Inferences from Data Findings

Both batch and inline production cleaning machines remove wet solder paste from misprint assemblies. Wash time and the four hour time window from stencil print to clean were not significant cleaning factors.

The significant factor is wiping the circuit board before cleaning. Wiping the wet solder paste potentially wedges solder ball on non-solder mask defined pads and other offset features that may be present on the circuit board. The data findings strongly infer that a misprinted circuit board should not be wiped before cleaning.

Designed Experiment #4: B-Side Misprints

During the wet solder paste loading designed experiments, both the inline and batch cleaning machines were loaded with 1000 grams of raw solder paste. The purpose of this experiment was to research the effectiveness of removing reflowed no-clean and water soluble lead-free flux residues on the surface and under a series of bottom termination components once the machine was loaded with raw solder paste.

B-side misprints are common on double sided boards populated with surface mount components. When the top side of a surface mount board is successfully stencil printed, components are placed, reflowed, cleaned and tested. A misprint that occurs on the B-side of the circuit board reflowed flux residue is on the A-Side and raw solder paste is on the B-side of the board.

B-side misprints create a much more challenging cleaning requirement. If the flux residues on the A-side of the circuit board are not cleaned before stencil printing and populating the B-side of the circuit board, the cleaning process used to remove the misprinted solder paste must not interact with the reflowed flux residue or must effectively clean the reflow flux residues during the cleaning process. A secondary issue is ionic contamination that can be left behind when the boards are cleaned in a process that is not design for production cleaning. Ionic residue left from inadequate rinsing can be far more problematic in risking electrochemical migration once the assembly is completed and in use.

Most assemblers do not allow misprints to be cleaned in production cleaning equipment. Unlike the machine designs discussed in this research paper, most production cleaning machines are not equipped to capture and filter out solder spheres. As a result, most assemblers either wipe the raw solder paste or clean the assembly in a machine designed for cleaning stencils. Both practices present reliability risks.

The objective of DOE #4 is to test the effectiveness of removing wet solder paste, reflowed flux residues and ionic contamination from B-side misprints. The factors and levels were as follows:

1. Bottom Termination Test Board
    a. Chip Cap Resistors
    b. BGAs
    c. μBGAs
    d. Single sided QFNs
    e. Double Sided QFNs
2. Solder Mask Definition
    a. Solder Mask Defined Pads
    b. Non-Solder Mask Defined Pads
    c. No-Solder Mask Defined Pads
3. Cleaning Machine
    a. Inline Spray-in-Air
    b. Batch Spray-in-Air
4. Wash Time
    a. Inline
        i. 8 minute wash
        ii. 4 minute wash
    b. Batch
        i. 15 minute wash
        ii. 20 minute wash
5. Cleaning Agent
    a. Aqueous Engineered #1
    b. Aqueous Engineered #2
6. Wash Temperature
    a. 65°C
7. Rinse
    a. Inline
        i. 4 minutes
        ii. 2 minutes
    b. Batch

i. 6 minutes

8. Ionic Contamination

a. Ionograph

Designed Experiment #4: Data Findings

Following the cleaning process, the A-Side of the circuit board was visually inspected to determine if reflowed flux residues were removed from boards processed in both the batch and inline cleaning machines. Figures 26 & 27 are images from the successful cleaning of the no clean flux residue on boards processed through the inline cleaning machine.

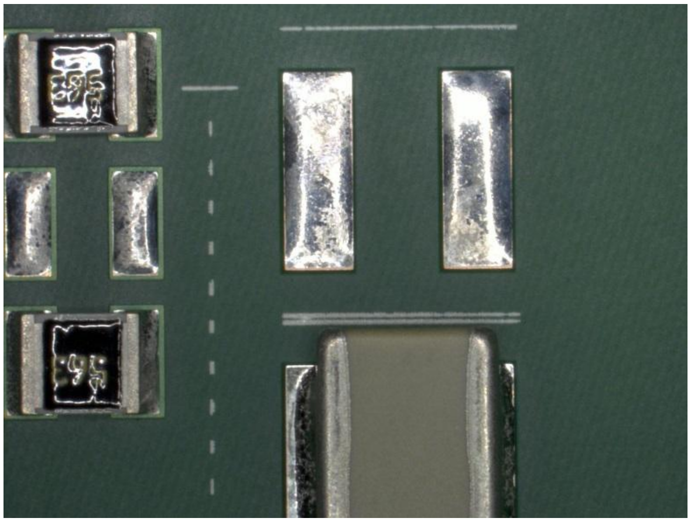

Figure 26: Inline Surface Cleaning Image

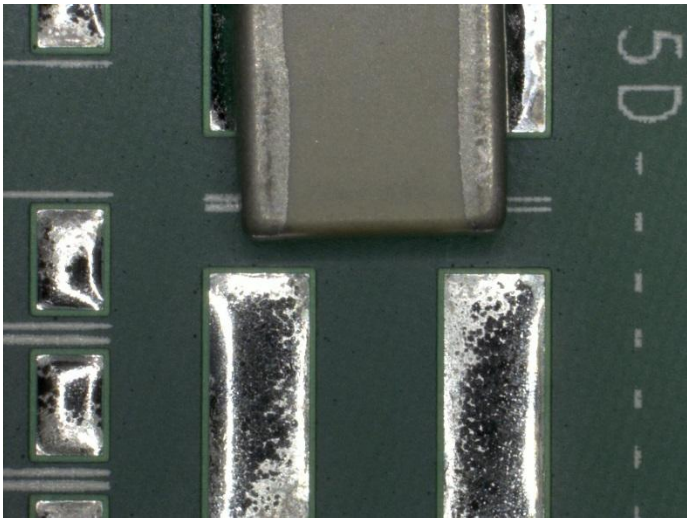

Figure 27: Batch Surface Cleaning Image

The single and double row QFNs were removed from boards processed in the inline and batch cleaning machines. The data findings of the level of flux residue under the bottom terminations are reported in Images 29 & 30.

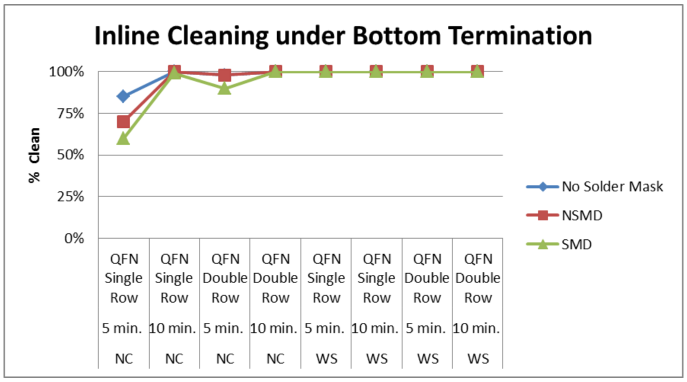

Figure 29: Inline Cleaning under QFN Bottom Termination

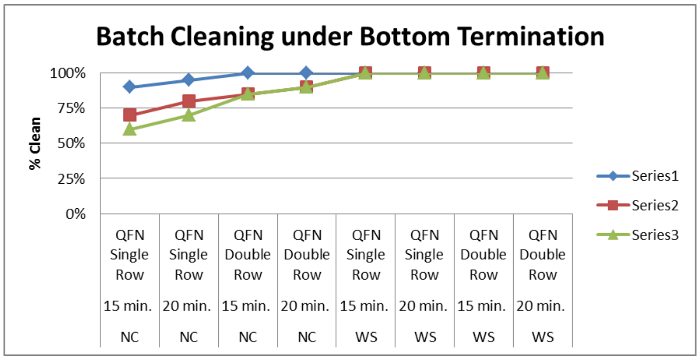

Figure 30: Batch Cleaning under QFN Bottom Termination

A subset of the boards was tested for ionic contamination levels using resistivity of solvent extract. For all boards tested, the total contamination was 00.0 µg. NaCl/sq.in.

Designed Experiment #4: Inferences from the Data Findings

Both the inline and batch cleaning machines are designed to clean populated circuit assemblies following the soldering process. DOE #4 finds that the levels of solder paste added to the machines did not have any adverse effect in removing reflowed flux residues. The boards were ionically clean under all test conditions following the cleaning processes.

RESEARCH CONCLUSIONS

Cleaning both A-Side and B-Side misprints has been a complex problem for assemblers. Using a stencil cleaner to clean misprints has numerous flaws as discussed in this paper. Most assembly houses do not allow misprints to be cleaned in production cleaning machines due to the risk of contaminating product boards with stray solder balls and due to waste water metal contamination issues.

The data from this research paper finds that the innovative collection and filtration systems designed into inline and batch production cleaning equipment safely captures and contains solder spheres from being sprayed onto production assemblies.

Additionally, the containment and filtration systems prevent raw solder paste from entering the rinse water streams.

Using a production cleaning machine provides numerous benefits to the assembler.

1. Recovery and rework of expensive hardware
2. Removal of wet solder paste
3. Containment of solder spheres
4. Removal of reflowed flux residues
5. Exceptional rinsing
6. Ionically clean assemblies
7. Repeatable
8. Reproducible

The research also found that wiping wet solder paste from production assemblies is a bad practice. When wiping wet solder paste, solder spheres can be wedged into no solder mask defined troughs, vias and other offsets. When these solder balls become wedged, high levels of energized sprays may not be sufficient in displacing a wedged solder ball. This research finds that best practice is to clean the misprint without wiping.

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