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Why is Rose Testing of PCB Assemblies a problem for Objective Evidence as required by Section 8 of the J-STD-001 Rev. H.

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Resistance of Solvent Extract (ROSE) testing is one of the oldest ionic cleanliness test methods in the industry. It continues to get applied to the newest electronics, without a second thought. It is not uncommon for things that were grandfathered into an industry or society to fly under the radar and escape scrutiny. An example of this is aspirin, which if it were to go through regulatory approval now, many medicinal chemists would expect it to be rejected due to the risks of its well documented side effects. Modern electronics have feature sizes, material sets (fluxes, solder alloys, etc.) and component densities that could not have been envisioned when ROSE was developed in the early 1970's. Does this mean ROSE is the aspirin of our industry - comfortably familiar and effective, or an anachronism ready for retirement? That is the question – Is it the right question and is it fair? I get asked this question a lot today as companies are trying to understand why they have field failures for bottom terminated components. "My ROSE testing results show no issues or problems, but yet I still have field failures on certain components or component types such as bottom terminated components", is the comment we hear frequently.. More specifically, the question before us is, "Is ROSE still capable of providing useful data in 2021?" This is some of the challenges and issues that ROSE testing has when trying to answer that question.

Higher density packaging has resulted in smaller components, closer signal and ground spacing, poor outgassing channels, and higher electric field gradients. When properly reflowed [and outgassed] modern fluxes leave behind a non-conductive benign residue. However, electrochemical failure occurs when two oppositely biased and closely spaced conductors are "connected" by a continuous electrolyte layer (such as moisture) that is in contact with a flux system that has an ionic residue or weak organic acid by product. Detection of residues that can drive failure requires a lead-to-lead, via to lead, and hole to hole testing techniques. The objective of a process control plan is to detect process deviations that can adversely affect system operations, and to validate that the assembly meets agreed upon quality requirements, thereby reducing the risk of failure when deployed in its final end use environment. The goal is a product that is repeatable, reproducible and performs as promised in the field. Rose does not have a way of measuring the electro chemical signature

or reaction on a lead to lead; via to lead; via to via; ground pad to signal pad on a singular basis to know if there is a problem present. Rose needs to measure the conductivity of dissolved ionics and weak organic acids in a solution and assumes that everything is equal as it relates to sodium chloride equivalent. The issues / problem can be as simple as these ionics have different conductivity levels and are not equivalent to the conductivity level of sodium chloride and some are not soluble at all in the DI water / Alcohol solution and sometimes, we cannot get the ionics out from under low standoff height components so they could be dissolved and measurable.

Listing of Rose Challenges as an effective process control tool:

ROSE TEST METHOD APPLICABILITY 1970'S VS 2020'S – DOES 50 YEARS MAKE A DIFFERENCE?

1. ROSE was developed 49 years ago to meet the needs of the current process technology of that day, and perceived challenges in the near future (low density SMT). – The year 1972/1973.
2. ROSE uses a conductivity meter which was designed around measuring highly conductive salts, such as sodium chloride.- The year 1972/73 – pine rosin flux systems – natural chlorides present.
3. ROSE was designed for large size PCB assemblies half a century ago, which utilized low density axial and radial through hole parts and pine rosin flux systems which had chloride ionics as its byproducts.
4. The fluxes that ROSE was developed to detect utilized highly conductive activators, typically chloride, in quantities that are no longer used today; vs. low conductivity weak organic acids used today.

Challenges (Problems) with using Rose Today 2020 vs 1970

1. ROSE testing was not designed nor can it measure weak organic acids and low conductivity anions reliably which is the foundation of today's no-clean flux systems
2. ROSE testing cannot dissolve flux residues and their associated weak organic acids and ionics under low standoff height components such as bottom terminated and large grid array devices and complex connector systems.
3. ROSE testing is a full board extraction which assumes there is enough flux residue present and available that can be dissolved into solution for measuring the overall cleanliness level of small to medium size PCB assemblies, which can be challenging because most flux systems are complex chemical formulations that are not easily dissolved in IPA/DI water solution. Correlation analysis between different size boards and their corresponding component density as well as their component type adds to the complexity of getting a meaningful measurement.
4. Cleanliness is really a local component type issue which is driven by each component types outgassing capability and thus this drives cleanliness to pad to pad or via to pad or ground pad to signal pads; and thus, one could view this as a point-to-point micro issue and not a whole board issue. Lead to lead; via to via; ground pad to signal pad – this is a point to point problem and not a whole board issue.
5. ROSE testing also has challenges in measuring the low level of contamination that is present on modern PCBs, i.e., the amount/ volume of ionic present - It appears to have potentially met the needs of the industry half a century ago, but not today. Today is really a component specific problem and a true localized electro chemical signature / cubic volume amount of that specific components' flux residue outgassing capability which is influenced by the flux type and your manufacturing process control.
6. ROSE has a limit of decision (LOC), where the false positive rate for contamination is 5% may be acceptable for sodium chloride, but not for weak organic acids.
7. For process control a more important metric is the limit of detection (LOD), which has only a 5% false negative rate (passing a contaminated PCB) is unacceptably high. For weak organic acids the LOD is orders of

magnitude higher than for sodium chloride. This adds a larger margin of error to ROSE testing when the ionic that is present is a low conductivity ionic such as weak organic acids.

8. Sodium chloride produces an apparently linear response with ROSE, however, for WOAs the response is not linear. The response of sodium chloride appears linear but fails goodness of fit tests.

9. ROSE is relatively "blind" towards weak organic acids that are used in modern no-clean fluxes, with a sensitivity order of magnitude lower than for sodium chloride. – weak organic acids requires a higher magnitude of volume present to be measurable than a higher conductivity chloride which can be detected at lower volume levels present.

10. Today flux systems are complex chemical formulations that use low conductivity weak organic acids and low conductivity thermal stabilizers and thus are blind to the conductivity cell detection systems used inside the Rose tester and this blindness requires a large amount of volume / concentration of a low conductivity ionic material to be detectable thus supporting the definition of Rose testing has "blindness" as it relates to modern flux systems or no -clean flux materials.

As one reviews the initial question: "Is ROSE still capable of providing useful data in 2021?" The above analysis is designed to help those make up their own mind as to the usefulness of Rose Testing in today's Electronic assembly process control methodologies and its data output. The real question does it answer the following question: How clean is "Clean" and is my electronics systems clean enough for my end use environment? Do you know the answer to this question: What is the cleanliness level of my electronic assembly? If you would like more information on this article's background then please pull down the following white paper and presentation from the 2021 SMTAI where I am one of the co-authors on the paper called: **Cleanliness Detection and Resistance of Solvent Extract – A Critical Evaluation**

What is a better electro chemical signature test for determining the cleanliness of an Electronic Printed Circuit Board assembly?
SIR testing is the test methodology that allows one to answer the question because its output gives a specific discriminating log ohm number (Electrochemical Signature) that allows one to answer the question: What is my cleanliness level on a specific electronic assembly? This number can be used to answer and build a qualified manufacturing process and it can also be used to answer the ionic process control monitoring question on a lot per lot basis.

If you have any questions or comments, please feel to email or call me at

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