



WHAT IS  
SCIENCE  
WITHOUT  
CARE?

# TECHNICAL REPORT

*Prepared For:*

## **Indium7.16 BiAgX™ HT Pb-Free Printing Solder Paste**

Because we want you to achieve the highest levels of performance, we connect care with leading science to continuously improve, problem solve and create the most effective cleaning solutions to suit your specific needs.

**KYZEN is an ISO 9001:2008 certified company.**

**Scope:** This document reports *Best Fit Cleaning Agent* process parameters for removing Indium7.16 Solder Paste flux residue. Solubility testing was used to evaluate the effectiveness of KYZEN's Electronic Assembly cleaning agents for removing the flux residue set.

**Objective:** To characterize the cleaning and solubility properties of Indium7.16 solder paste flux residue.

Indium7.16 is a "Drop-in" Pb-free replacement solder paste for high lead(Pb) solder paste application. This paste is developed for reliable automatic SMT screen print processes. Solder joints made with BiAgX™ will work well even in high-temperature environments in excess of 150°C, with minimal degradation of the final joint mechanical structure and little or no deterioration in electrical and thermal performance. It contains no costly specialty materials, such as nanoparticles or gold.

### **Process Cleaning Rate**

The process cleaning rate theorem holds that the rate at which a solvent or cleaning agent dissolves a residue (static rate) plus mechanical energy (dynamic rate) equals the process cleaning rate. To determine the **static** cleaning rate (rate at which the cleaning agent dissolves the residue in the absence of mechanical energy), KYZEN uses two **static** cleaning tests. The first test (Phase 1) develops a Hansen Solubility Parameter for each flux residue. The Hansen Solubility Parameter provides insight into the material sets that dissolve the residue. The Phase 1 test exposes the processed flux residue on test coupons to a series of solvents with known solubility parameters. The test coupons are graded (Figure 1) based on each solvent's ability to dissolve the residue.

The confidential Phase 1 test values will not be included in this report however they are available upon request.

The second test (Phase 2) exposes each processed flux residue to different KYZEN cleaning agents in an effort to match up the right cleaning agent to the soil matrix. This testing provides insight into the technology base options for cleaning the specific residue set.

### **Procedure: Phase 2 - Matching the Cleaning Agent to the Flux Residue**

The objective of Phase 2 testing is to develop the static cleaning rate. Static cleaning rates measure the cleaning agent's affinity to dissolve the soil in the absence of mechanical forces. High static cleaning rates indicate a strong match for the soil in question.

Wash concentration of the Aquanox materials was set at 10, 15 and 20% and testing temperature was 20, 40 and 60°C.

The semi - aqueous materials are processed as neat solutions. Testing temperature was 20, 40 and 60°C.

The vapor degreaser solvents Micronox MX2501 and Ionox I3955 were evaluated only at ambient temperature

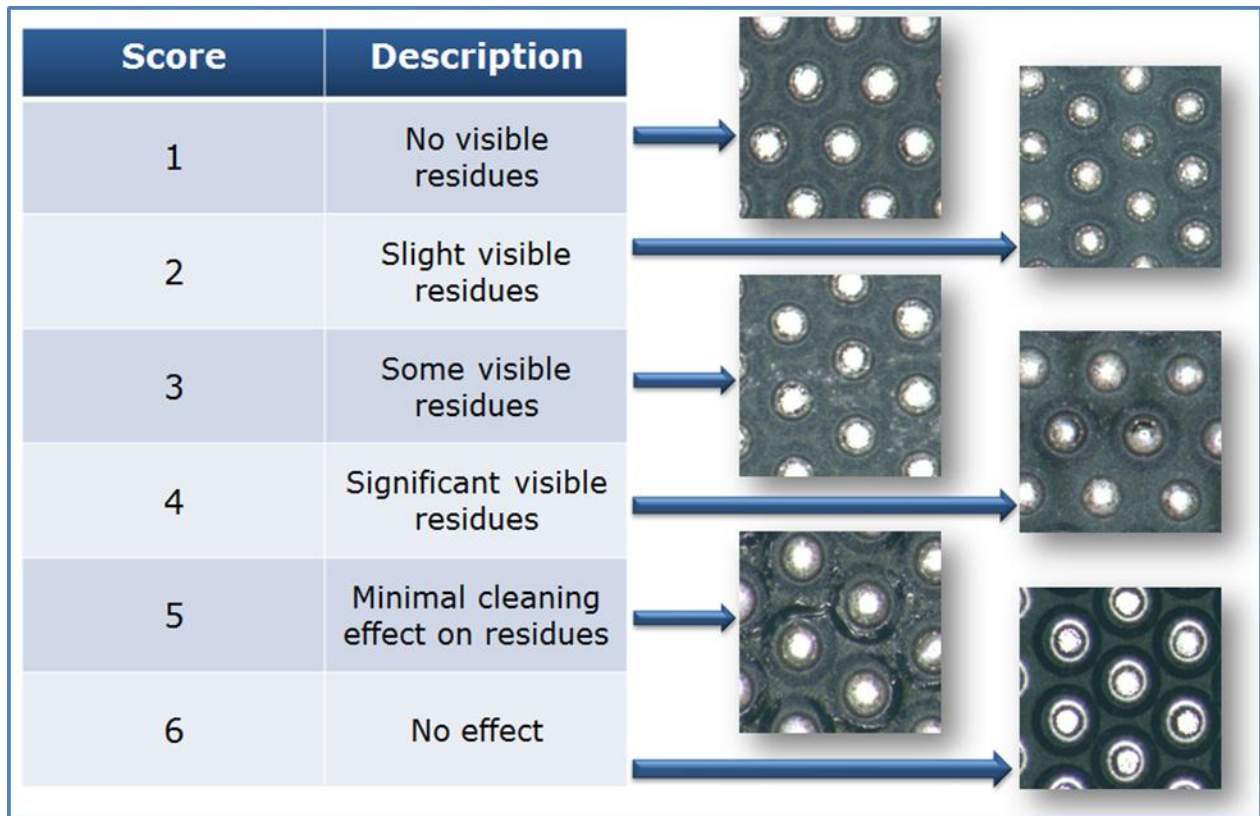
Cybersolv 141R was evaluated at ambient temperature as designed.

Time is fixed at 10 minutes.

The test vials are rotated at specific temperatures in a LabRoller to assure that the cleaning agent is well mixed during the test. After the 10-minute exposure the coupons are rinsed and dried, observed at 10-30x and the test scores logged into Minitab software.

Figure 1 illustrates the grading scale used to score the test coupons.





**Figure 1: Grading Scale 1-6**

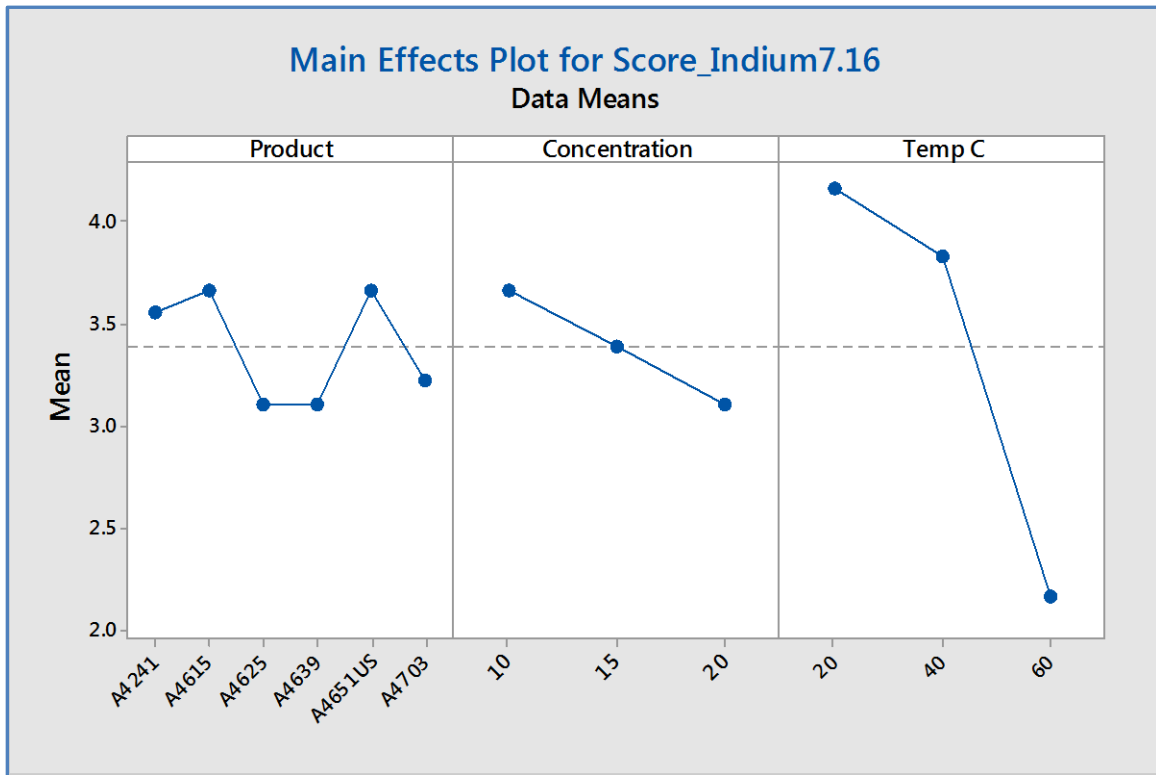
**Data Findings:**

The response scores were placed into Minitab statistical software package. The main effects plot provides insight into the cleaning agents that best match up with the Indium7.16 flux residue. The cleaning agents tested were grouped into the following product categories:

1. Aqueous Defluxing
2. Semi Aqueous and Solvent Defluxing



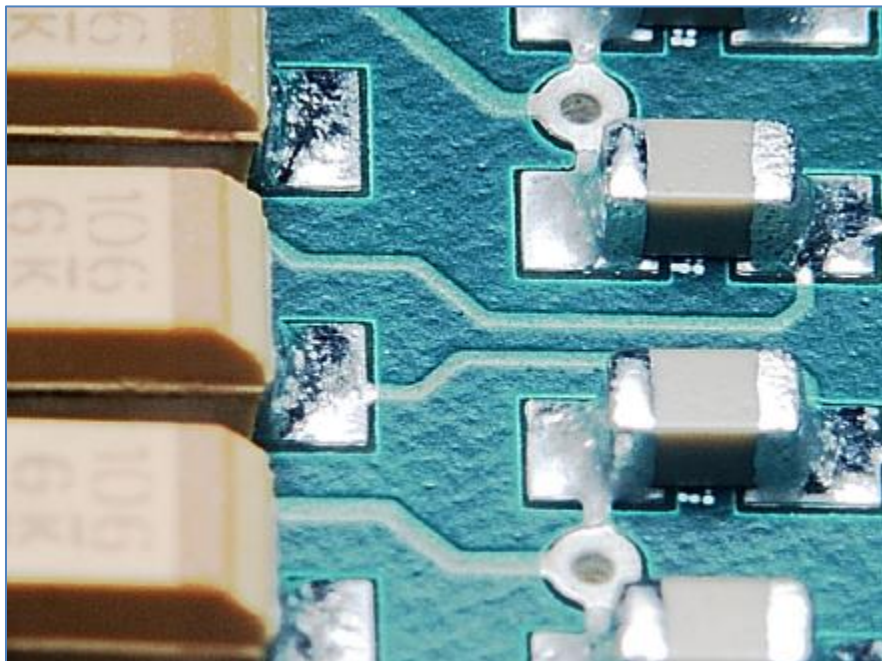
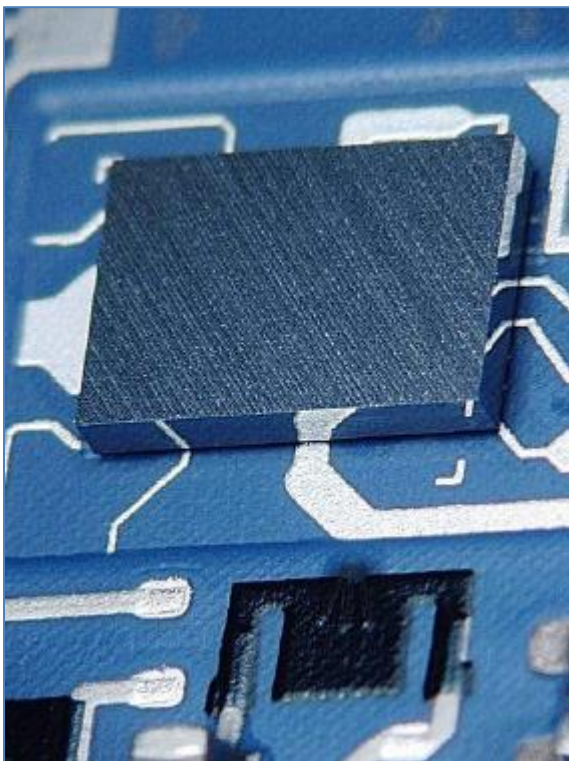
## AQUEOUS CLEANING AGENTS



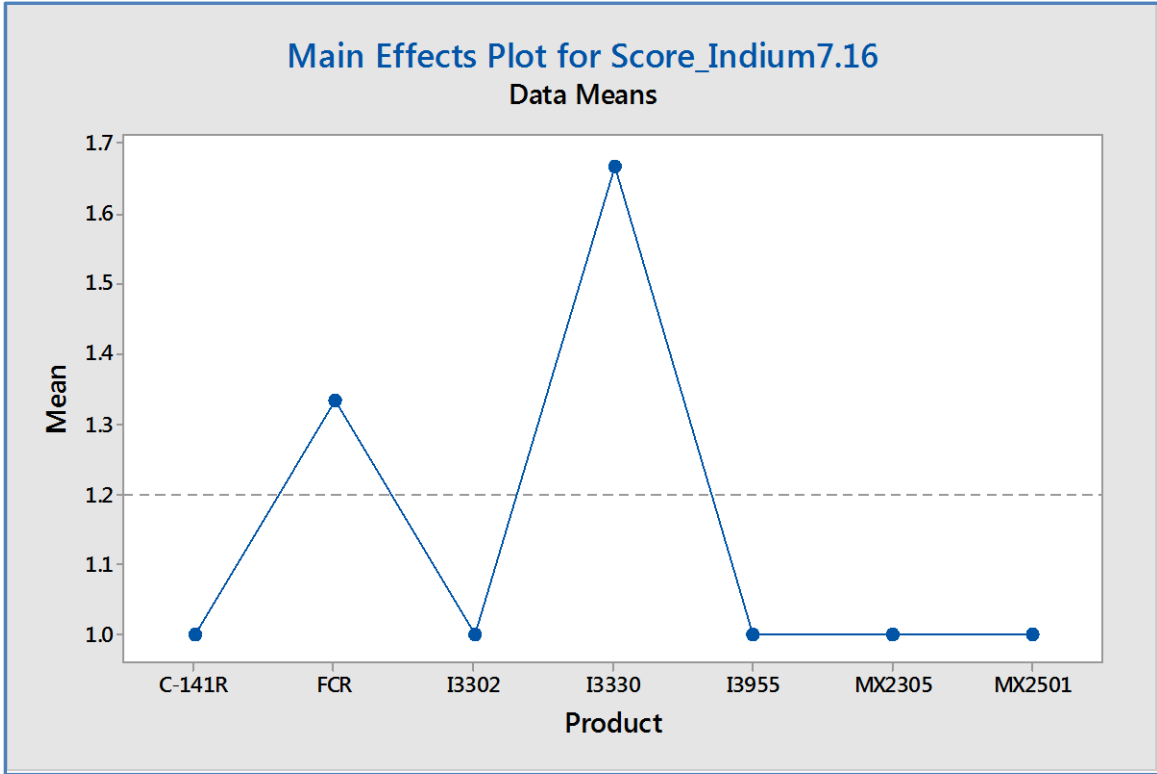
1. Aquanox A4241 is an engineered aqueous cleaning agent designed to remove all flux residues with spray in air cleaning equipment. The static testing indicates that Aquanox A4241 is effective at removing Indium7.16 series flux residue.
2. Aquanox A4615 is an engineered inorganic based aqueous cleaning agent designed for use in highly populated areas with stringent VOC air regulations. Aquanox A4615 is designed for use with spray in air and ultrasonic cleaning equipment. The static testing indicates that Aquanox A4615 is marginally effective at removing Indium 7.08 flux residue.
3. Aquanox A4625 is an engineered aqueous cleaning agent designed to remove all flux residues with spray in air cleaning equipment. The static testing indicates that Aquanox A4625 is most effective at removing Indium7.16 flux residue.
4. Aquanox A4639 is a next generation single chamber batch cleaning solution that provides exceptional cleaning results and protection of metallic surfaces with minimal monitoring and no sump-side additives. The static testing indicates that Aquanox A4639 is most effective at removing Indium7.16 flux residue.
5. Aquanox A4651US is a low pH aqueous cleaning solution designed exclusively for use in ultrasonic immersion cleaning systems. The static testing indicates that Aquanox A4651US is marginally effective at removing Indium 7.08 flux residue.
6. Aquanox A4703 is a pH neutral range engineered aqueous cleaning agent designed to remove reflowed & wave solder flux residues with spray in air cleaning equipment. The static testing indicates that Aquanox A4703 is effective at removing Indium7.16 flux residue.

**Aqueous Cleaning Recommendations – Indium7.16**

<b>Cleaning Agent</b>	<b>Soil</b>	<b>Wash Conc.</b>	<b>Wash Temp.</b>	<b>Cleaning Tool</b>
Aquanox A4241	Reflowed Flux Residue	25-30%	60°C	Batch & Inline SIA
Aquanox A4615	Reflowed Flux Residue	NR	NR	NR
Aquanox A4625	Reflowed Flux Residue	15-20%	60°C	Batch & Inline SIA
Aquanox A4639	Reflowed Flux Residue	15-20%	60°C	Batch SIA
Aquanox A4651US	Reflowed Flux Residue	25%	60°C	Ultrasonic
Aquanox A4703	Reflowed Flux Residue	15-25%	60°C	Batch & Inline SIA



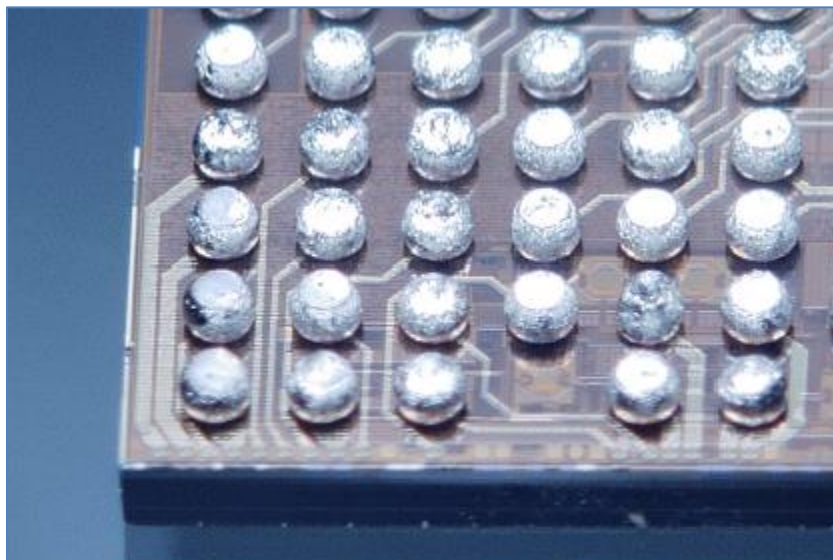
## SEMI-AQUEOUS CLEANING AGENTS



1. Ionox I3330 is a semi-aqueous cleaning agent designed to remove reflowed and wave solder flux residues. The static testing indicates that Ionox I3330 is effective at removing Indium7.16 flux residue.
2. Ionox I3302 is a semi-aqueous cleaning agent designed as a broad spectrum high strength solvent for SMT assemblies, semiconductor, flip-chip and wafer level packaging. The static testing indicates that Ionox I3302 is most effective at removing Indium7.16 residue.
3. Ionox FCR is a high strength concentrated cleaner containing a blend of organic solvents and inhibitors. It is multi-metal safe and can be used in immersion agitation, ultrasonic or centrifugal systems. As a legacy cleaning solution Ionox FCR is effective for the removal of virtually all types of pastes and fluxes including rosin, low residue/no-clean and organic acid flux. The static testing indicates that Ionox FCR is most effective at removing Indium7.16 flux residue.
4. Cybersolv® 141-R is a precision cleaner blend of organic solvents that is safe and ready to use for bench-top electronics cleaning. 141-R is effective on a wide variety of soils typically found in electronic assembly and maintenance cleaning applications.
5. Micronox MX2305 is an engineered semi-aqueous solvent blend designed to remove difficult flux and paste residues including lead-free, rosin, no-clean, and tacky flux from wafer bumps found in flip chip, chip scale and  $\mu$ BGA packages. The static testing indicates that Micronox MX2305 is most effective at removing Indium7.16 flux residue flux residue
6. Micronox MX2501 is an engineered vapor cleaning solvent containing a blend of hydro-fluoroether, hydrofluoro-carbon, trans-1,2-di-chloroethylene (t-DCE) and alcohol. It is multi-metal safe and can be used in traditional vapor degreasing systems for removal of dirt, grime, oils, greases, finger prints, polymer dust, flux paste and process residues from metals, plastics, glass and ceramics. The static testing indicates that Micronox MX2501 is most effective at removing Indium7.16 flux residue flux residue.

7. IONOX® I3955 is a precision vapor cleaning solvent designed as a drop in replacement for modern era vapor degreasing equipment. Ionox I3955 is blended from n-Propyl bromide. I3955 is effective in removing no clean and rosin flux residues from electronic assemblies including low stand-offs and micro-BGA's.

<b>Semi-Aqueous &amp; Solvent Cleaning Recommendations - Indium7.16</b>				
<b>Cleaning Agent</b>	<b>Soil</b>	<b>Wash Conc.</b>	<b>Wash Temp.</b>	<b>Cleaning Tool</b>
Ionox I3330	Solder Paste Reflowed Flux Residue	100%	60°C	Spray Under Immersion, Ultrasonic & Direct Energy Wet Bench Processes
Ionox I3335	Solder Paste Reflowed Flux Residue	100%	60°C	Spray Under Immersion, Ultrasonic & Direct Energy Wet Bench Processes
Ionox I3302	Solder Paste Reflowed Flux Residue	100%	40-60°C	Spray Under Immersion, Ultrasonic & Direct Energy Wet Bench Processes
Ionox FCR	Solder Paste Reflowed Flux Residue	100%	60°C	Spray Under Immersion, Ultrasonic & Direct Energy Wet Bench Processes
Cybersolv 141-R	Flux Residue	100%	Ambient	Manual
Micronox MX2305	Solder Paste Reflowed Flux Residue	100%	60°C	Spray Under Immersion, Ultrasonic & Direct Energy Wet Bench Processes
Micronox MX2501	Solder Paste Reflowed Flux Residue	100%	At boil	Vapor Degreaser Process
Ionox I3955	Solder Paste Reflowed Flux Residue	100%	At boil	Vapor Degreaser Process



### Phase 3: Dynamic Cleaning Energy

The third important cleaning parameter is represented by the energy used to deliver the cleaning agent to the soil. Fluid dynamics increase the cleaning rate using fluid flow and pressure.

Aqueous cleaning processes are dramatically improved with dynamic cleaning energy and temperature. One benefit when formulating aqueous cleaning agents is the ability to engineer a material set that matches up to the residue. The concentration range for these products is typically 10% to 20% for No-clean and rosin fluxes and 3-8% for water soluble fluxes.

Applying spray in air impingement energy and elevated wash temperatures opens the process window for excellent cleaning results. The data in this report characterized both the flux residue and cleaning agents.

Semi-aqueous cleaning agents drive more with the static rate than with the dynamic rate. The solvency of semi-aqueous cleaning agents with the flux soil is a critical parameter for predicting cleaning performance.

The Ideal Cleaning Condition is dependent on many factors and does not solely rest on the cleaning agent. It is important to review the variables present as outlined in below Figure 2.

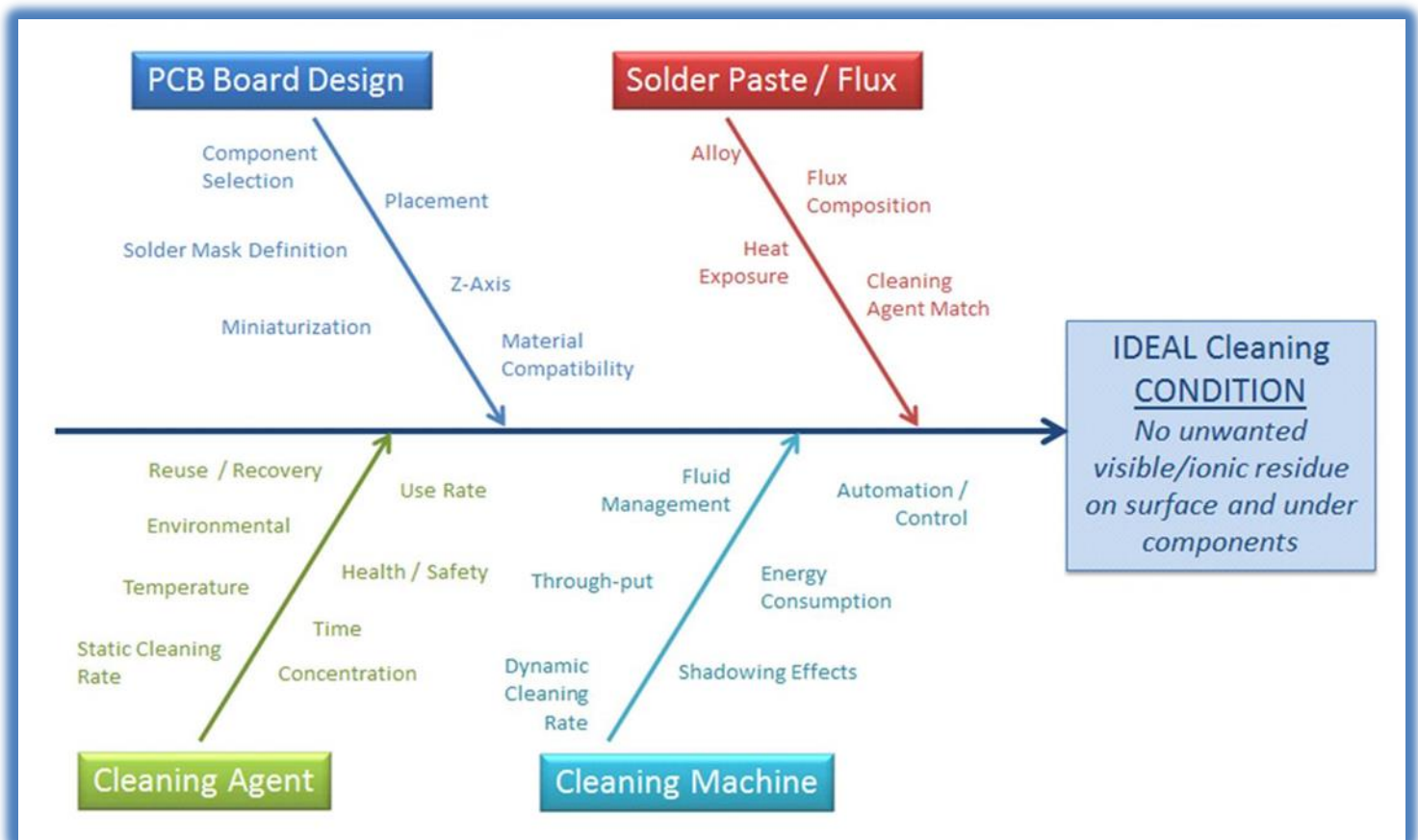


Figure 2

### Inferences and Recommendations from the Data

Static material property testing confirms that solder flux residues are different in composition and their ability to be cleaned must be closely matched to the cleaning agent. The data in this report characterized both the flux residue and cleaning agents. This data is important when designing your cleaning process.



Achieving proper cleanliness levels has become more challenging due to;

- Highly dense component placements
- Component configurations
- Low clearance with a lot of flux underneath
- Flux residues that form a hard clear shell require longer wash times to dissolve in the cleaning agent, thus requiring increased wash bath exposure time to effectively clean these residues.

The data finds that Indium7.16 flux has shown to be cleanable when exposed to KYZEN cleaning solutions. However, most importantly a carefully defined wash process must be in place to effectively clean this no clean flux formula.

For bench top and spot rework cleaning KYZEN Cybersolv 141R is recommended. As the report details, KYZEN engineers a wide range of cleaning agents designed to match up with client needs. Contact your local KYZEN representative for the best recommendation and product samples for testing.

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## STATEMENT OF TESTING INTEGRITY

KYZEN certifies that the information, methods and data within this report are true and accurate. Customers are encouraged to visit KYZEN to witness any and all tests performed. Please contact your KYZEN representative for more information.

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