Mike Bixenman, Ph.D.

CTO
Kyzen Corporation
mikeb@kyzen.com

Biography:
Dr. Bixenman is a co-founder and CTO of Kyzen Corporation. An active researcher and innovator in the field of precision cleaning, he chaired the committee that developed IPC cleaning & Alternatives Handbook and IPC Stencil Cleaning Handbook as well as two IPC/SMTA Cleaning and Conformal Coating Conferences. Dr. Bixenman holds four degrees, including a doctorate in business administration.

Title:
Dual Solvent Electronic Assembly Cleaning

Abstract:
Electronic Assemblies are cleaned in order to remove contaminations that may affect yields, service life and reliability. Highly dense interconnects entrap flux residues under the Z-axis. Volatile solvents commonly used for cleaning include trichloroethylene, normal propyl bromide and a variety of other blended compounds (HFE, HFC, HCFC, etc.). Some of these solvent can have negative effects on the environment and workers. Alternative volatile solvents suitable for cleaning highly dense interconnects are needed. The purpose of this research to introduce an innovative method for cleaning electronic assemblies using a low volatile cleaning fluid followed by rinsing in an environmentally safe volatile solvent. Dual solvent cleaning provides a means for engineering cleaning fluids that match up to the soil and to be rinsed using a volatile solvent blend. This research will also report process integration between the cleaning fluids, cleaning equipment, and solvent recovery.

Dual Solvent Electronic Assembly Cleaning

Joe McChesney
Controls System Design
Mike Bixenman
Kyzen Corporation

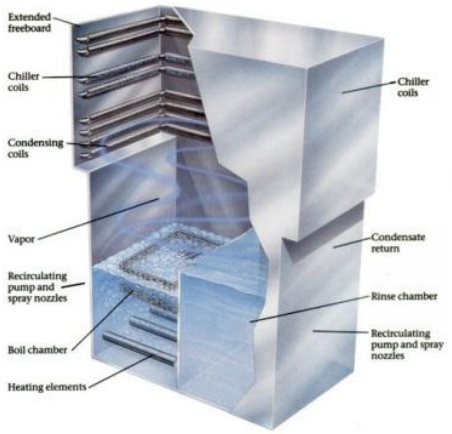
Presentation Overview

- Solvent Cleaning Approach
- Benefits / Tradeoffs
- Current Solvent Cleaning Methods
- EAC Cleaning Challenges
- Improving Solvent Cleaning Processes
  - Cleaning Agent
  - Rinsing Agent
  - System Design
- Concluding Remarks

SOLVENT CLEANING APPROACH

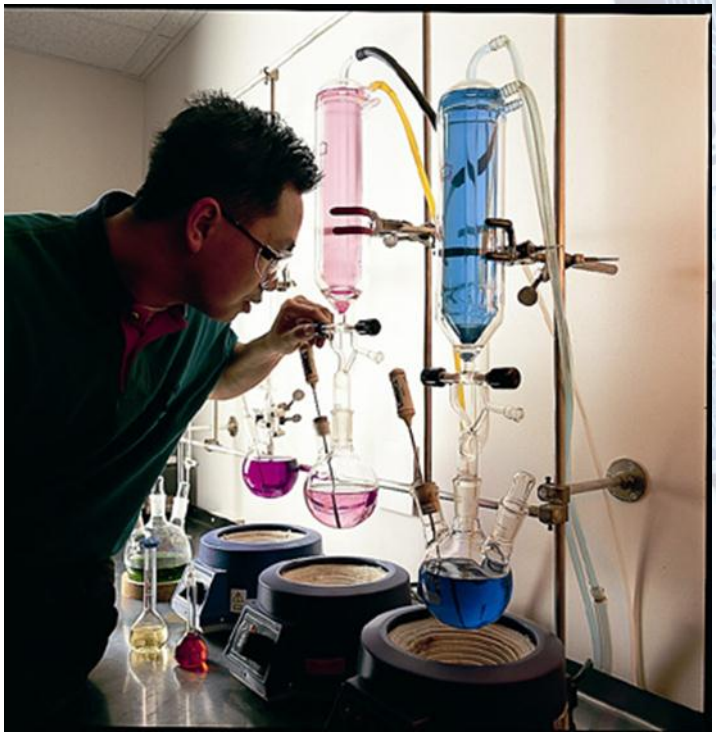
Solvent Cleaning Agents

- Cleaning agent which readily evaporates after use
- The cleaning agent is designed to
  - Dissolve the soil
    - Often as a non-volatile residue
  - Rinse the part with clean solvent
  - Dry the part with at the solvent vapor point



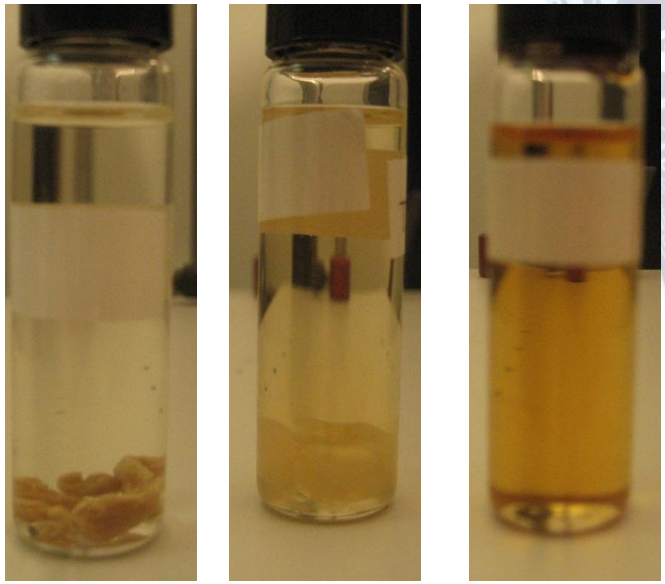
Solvent Cleaning Agents

- Solvent cleaning combines
  - A single solvent
  - Mixture of solvents



Solvent Cleaning Agents

- Solvents cleaning agents are based on
  - Ability to dissolve a soil
  - Boiling point
  - Heat of Vaporization
  - Stability
  - Recovery and Reuse
  - Toxicity



Solvent Cleaning Agents

- Up until the mid 1990s
  - Most cleaning processes used chlorinated solvents with ozone depleting compounds
- Regulatory constraints led to
  - Cleaning disruption
  - No drop-in substitute without regulatory issues
  - Cleaning market fragmented

Volatility

- Solvents cleaners are designed to evaporate from the surface, even after cold-cleaning
- Typically have a vapor pressure greater than 25 Torr at ambient temperatures (1mm Hg = 1 Torr)
- Some compare evaporation rate to n-butyl acetate
- Heat of vaporization is related to volatility

Solubility in the Solvent

- The type of compounds that dissolve in a solvent are based on the solvent's
  - Polarity
  - Dipole moment
  - Hydrogen bonding
- As a rule of thumb
  - Polar solvents dissolve polar soils best
  - Non-polar solvents dissolve non-polar soils best

BENEFITS / TRADEOFFS

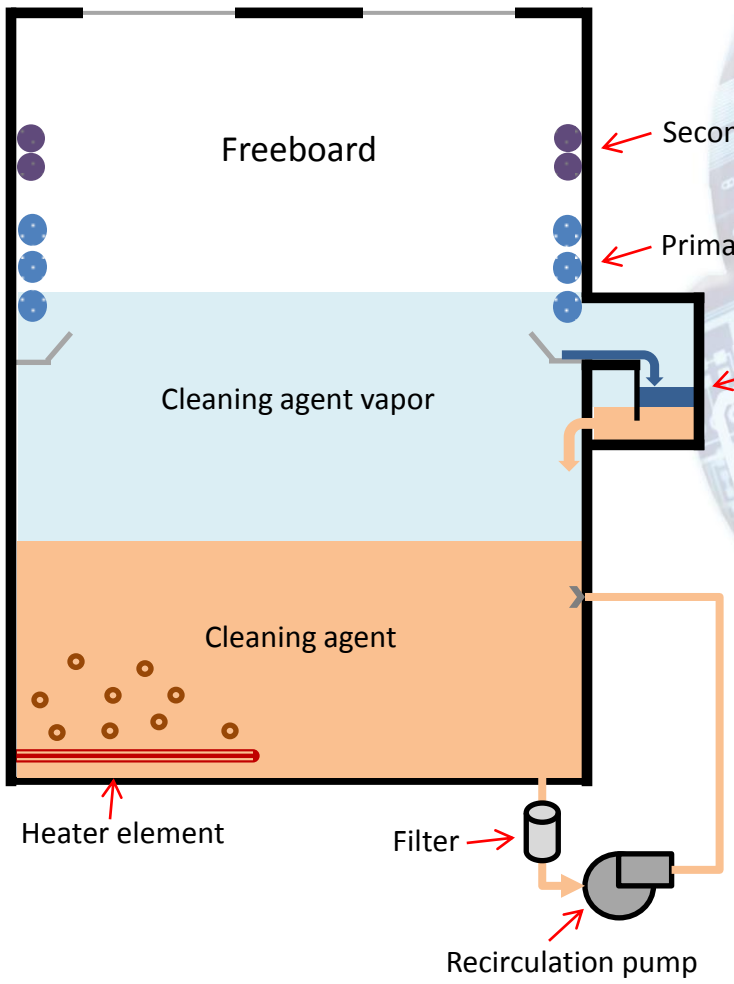
Solvent Cleaning

- Benefits
  - Simple
  - Recoverable
  - Low surface tension
  - Cleaning tight gaps
- Tradeoffs
  - Environmental issues
  - Difficult to match up to multiple soil types
  - Solvent costs
  - Worker exposure limits

CURRENT SOLVENT CLEANING METHODS

Neat Cleaning Process

- Single component
- Mild cleaning



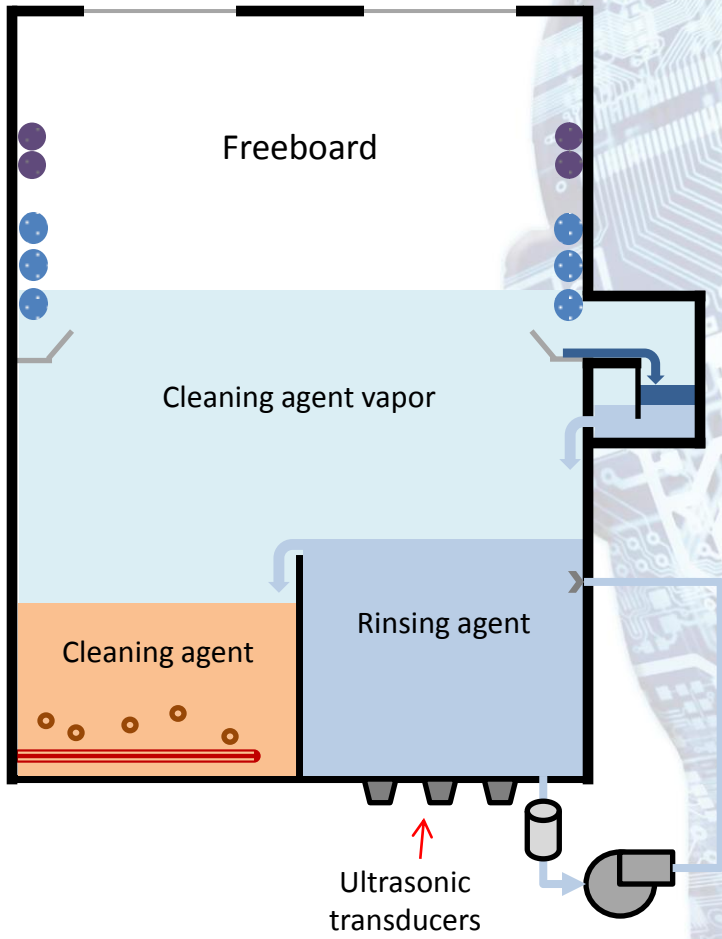
Source: Owens (2011)

HFE Neat (single sump) cleaning

Solvent Blend Cleaning Process

- Azeotrope
- Azeotrope-Like
- Effective on
  - Rosin
  - Some no-clean
- Poor on
  - Water soluble
  - Lead-free no-clean

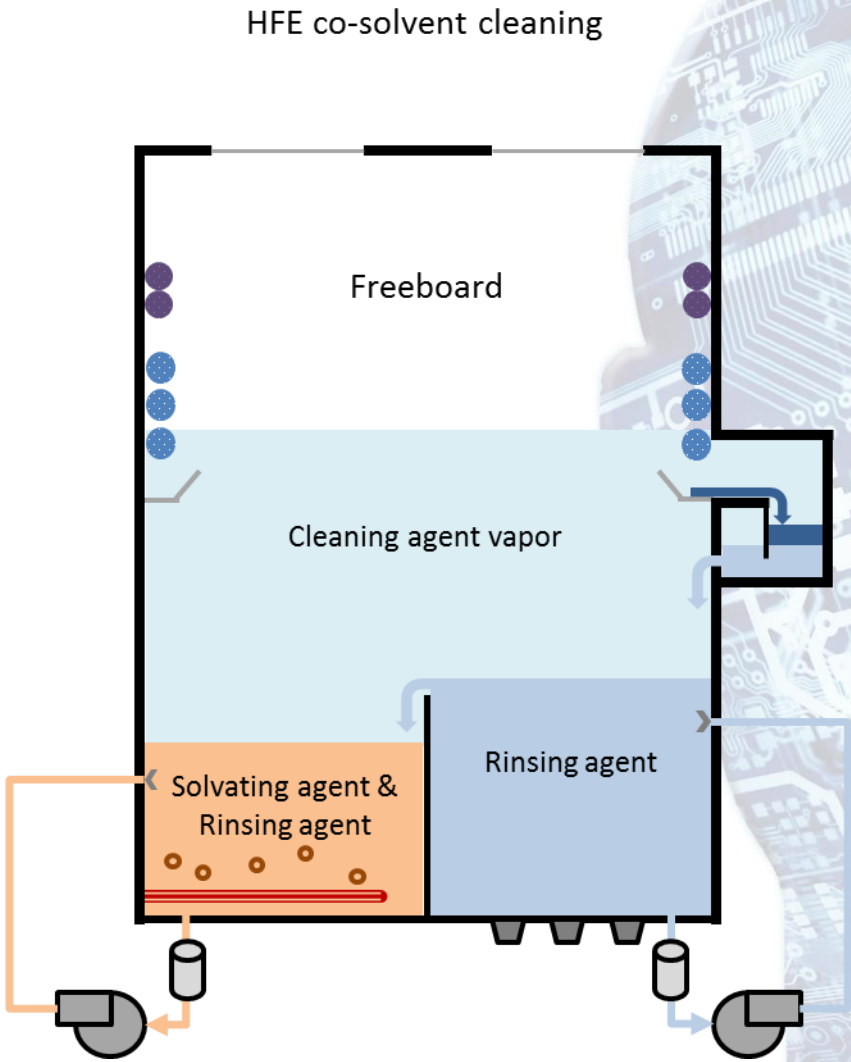
HFE Stereotropic (multi-sump) cleaning



Source: Owens (2011)

Co-Solvent

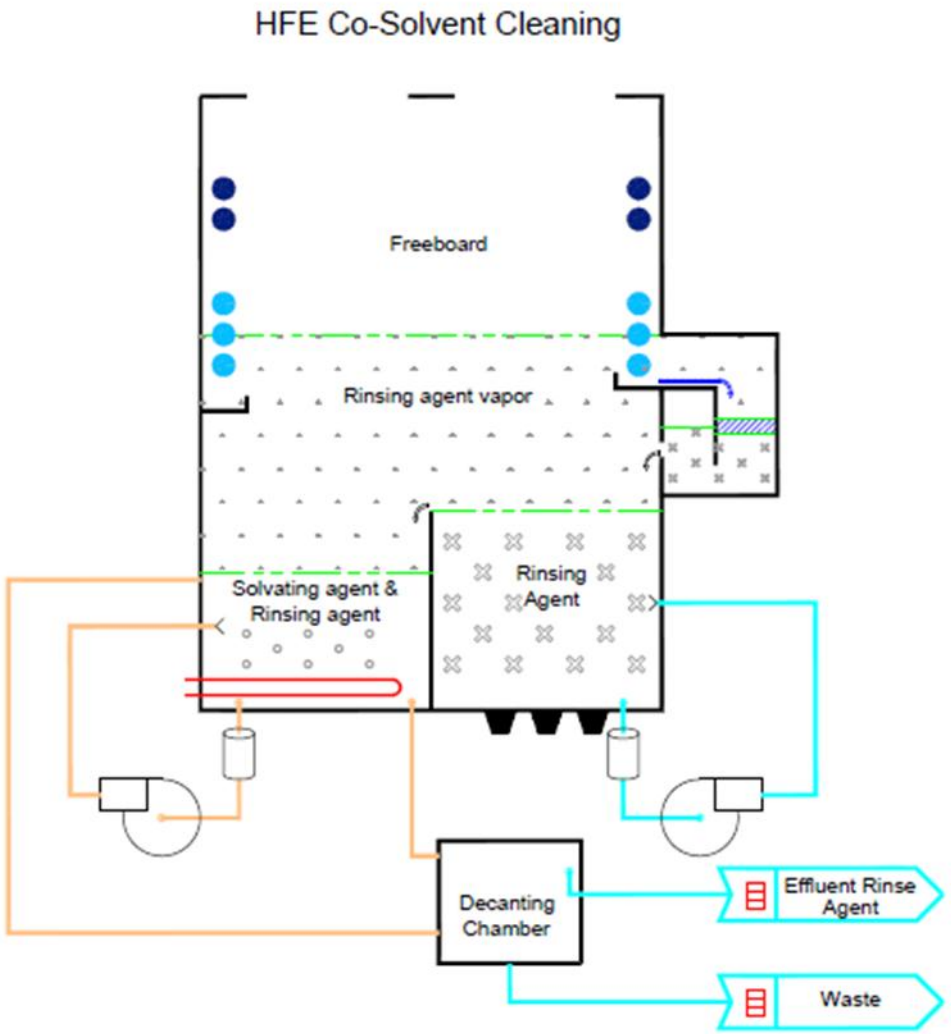
- Cleaning fluid in a rinse fluid
- Cleaning fluid
  - Low volatility solvent
- Rinsing fluid
  - Fluorinated solvent



Source: Owens (2011)

Bi-Solvent Cleaning Process

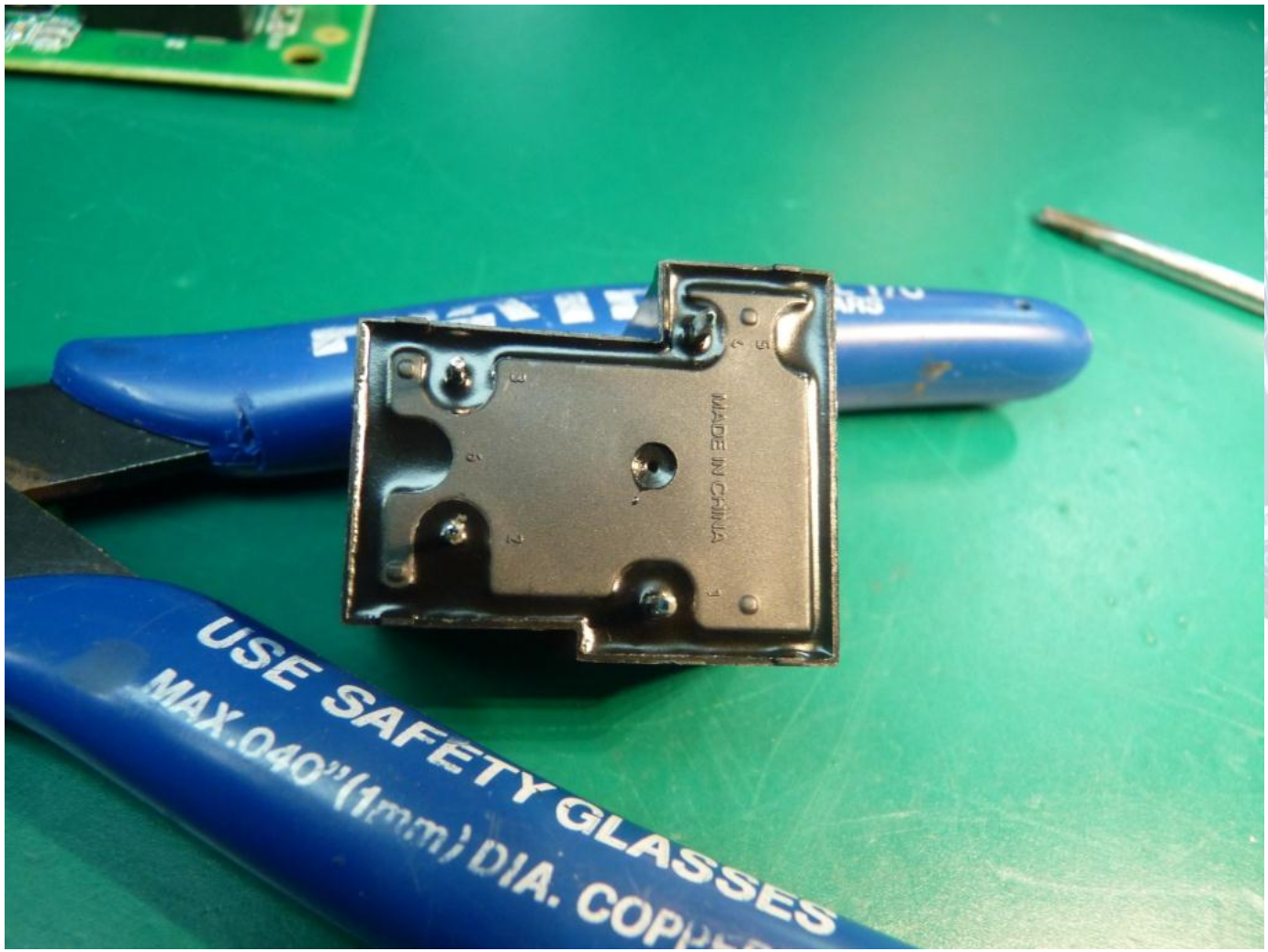
- Two different cleaning chambers
  - Low volatility organic solvent
  - Rinsing solvent



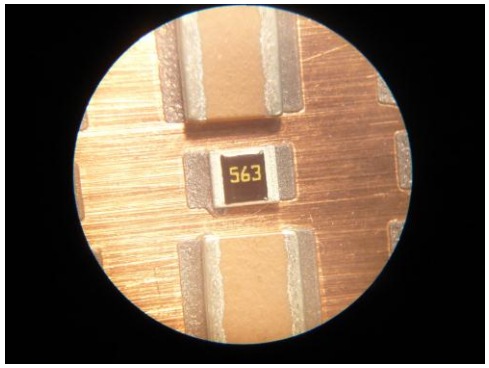
Source: Owens (2011)

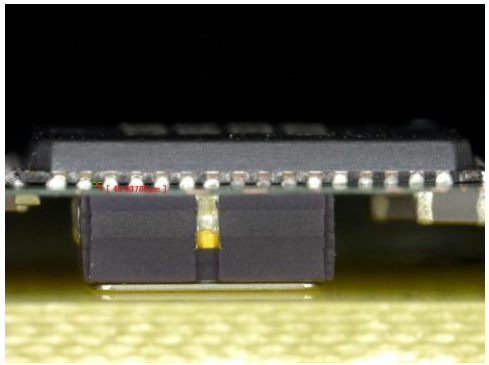
EAC CLEANING CHALLENGES

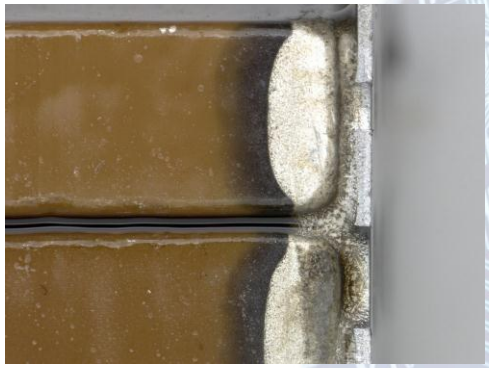
Non-Hermetically Sealed Components

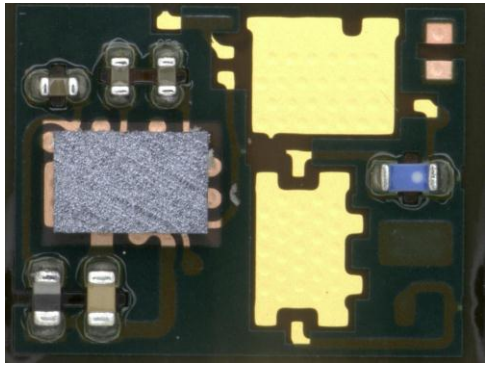


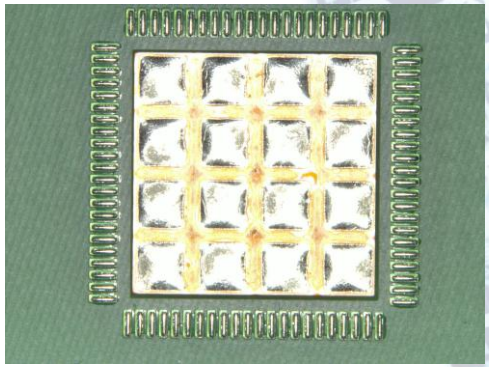
Cleaning HDI











IMPROVING SOLVENT CLEANING PROCESSES

Solvent Based Cleaning Agents

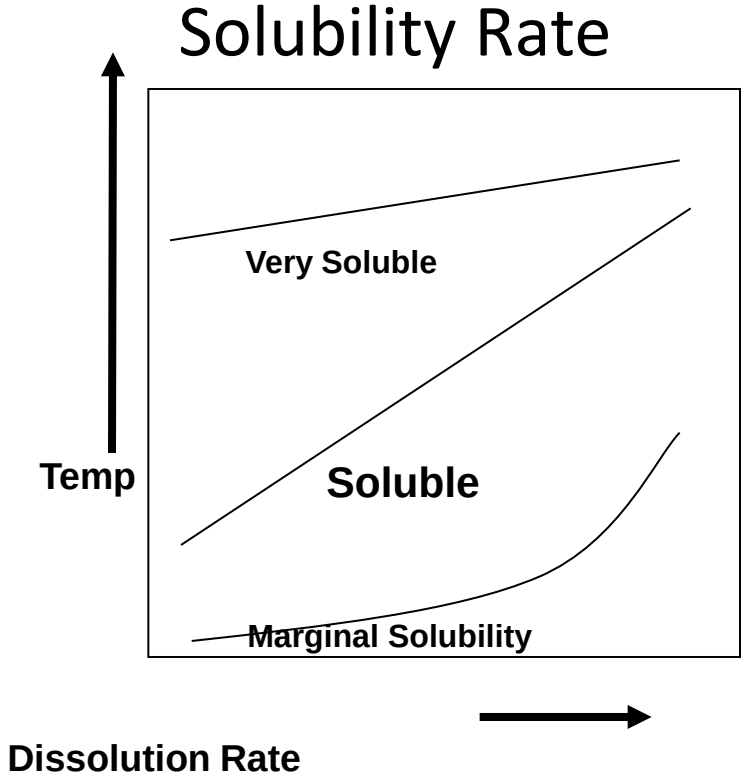
- Composition can be a
  1. Blend – mixture of solvents with different chemical properties
  2. Azeotrope – mixture of solvents with a constant boiling point
  3. *Low volatile solvent that is rinsed with a highly volatile solvent*

Solvent Cleaning

- Dissolve the soil
- Soil forms a solution with the solvent
- Key challenges
  - Solvent matches with soil
  - Remove the soil from the solvent
  - Recover the solvent

Cleaning Agent Contribution

- "Dissolve-it"
  - Solubility theorems
  - Augmented with heat, pressure, and flow
- Rate of solubility
  - Dependent on soil properties
  - Temperature effect in dissolving residue
  - Solvent match to the soil



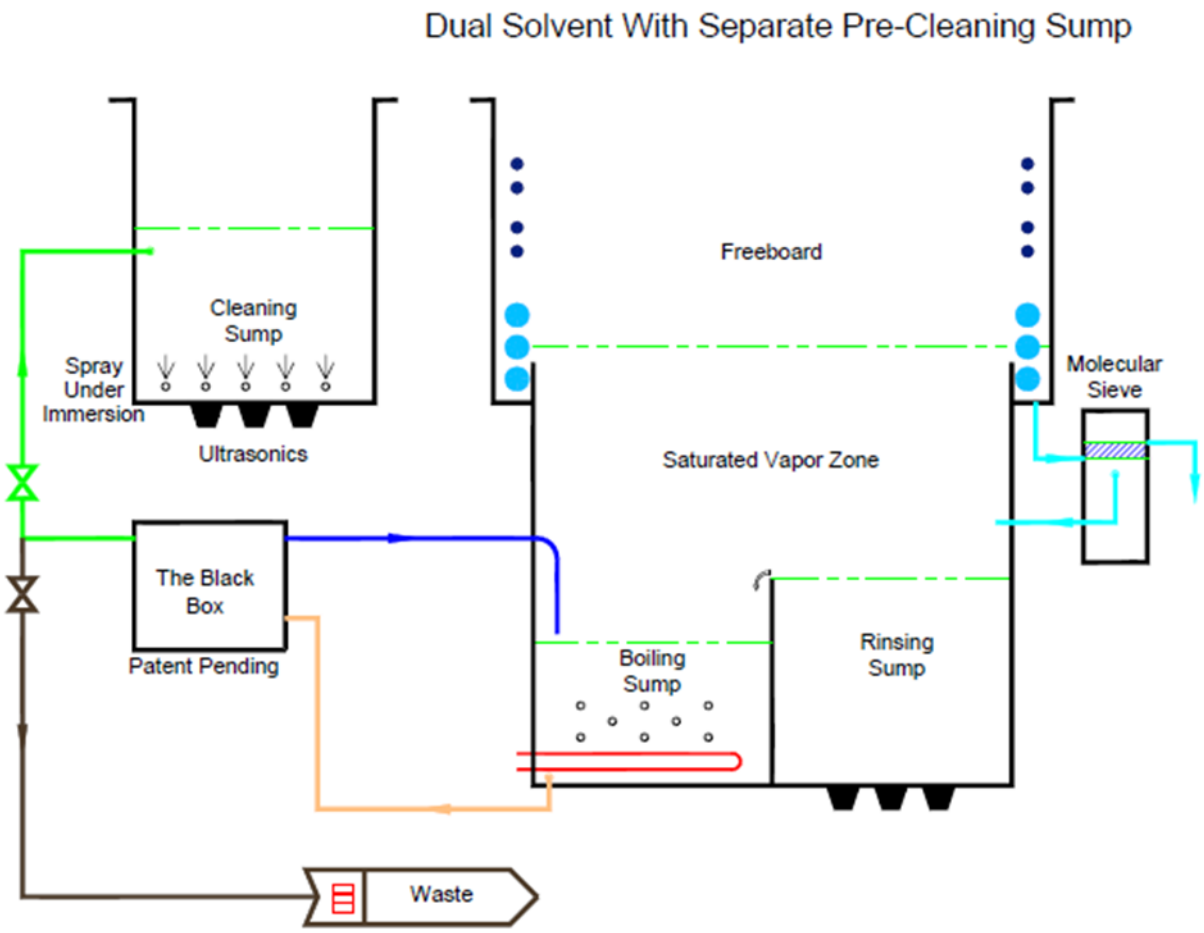
Relative Cleaning Effectiveness

Category 1 (Polar or Ionic)	Category 2 (Nonpolar or Nonionic)	Category 3 (Particulate)
Raw Flux Activators - Weak Organic Acids - Amino Halogenated	Unreflowed Flux Resin & Rosins - stencils - misprints	Resin and Fiberglass Debris - drilling and/or punching operations
Activator Residues - Flux Residue - Paste Fluxes	Flux Residues - Water Soluble - Rosin - No-Clean	Metal and Plastic Chips - machining and/or trimming - general use
Fingerprints (sodium & potassium chlorides) - handling	Waxes - equipment maintenance	Dust & Lint - equipment maintenance - general use
Organic Amines - Cations - Water Soluble Fluxes	Fingerprints (skin oils) - handling	Hair / Skin - handling - general use
Surfactants (ionic) - Water Soluble Flux - Spot Mask	Oils & Greases - equipment maintenance - ovens - printers	

Rinsing Fluid

- Mild and Low toxicity solvents
  - Non ozone depleting
  - Non flammable
  - Stable
- Low Boiling points
- Solvent Cleaning agent can be separated from rinse fluid
- Dries spot free with no residue remaining
- Examples are
  - HFEs
  - HFCs

Dual Solvent Cleaning Process



CONCLUSIONS

Dual Solvent Process

- Improves solvent cleaning process by
  - Engineering solvents that match up with the soil
  - Makes full use of environmental rinse solvents
- Best Available Control Technology
  - Isolate contamination from rinse fluid
  - Recover rinse fluid real time
  - Recover solvating agent
  - Reduce waste
  - Improve cleaning
  - Lower cost of cleaning

Questions

Authors:

Joe McChesney
CSD Automation
joe.mcchesney@controlsystemsdesign.com

Mike Bixenman
Kyzen Corporation
mikeb@kyzen.com