Halogen-Free Overview

Halogen	Halide
What is the chemical nature of the element?	
These elements are covalently bonded within a flux residue	These elements are ionic constituents in the flux as supplied (referred to as -ides, ie "Chloride")
Which elements are tested?	
Chlorine (Cl) and Bromine (Br)	Fluorine (Fl), Chlorine (Cl), Bromine (Br), and Iodine (I)
What is the source of concern?	
Environmental: Uncontrolled incineration, potential dioxin formation during electronics recycling	Reliability: Increased potential for corrosion and dendritic growth on electronics assemblies
Which parts of an electronics assembly contain these elements?	
Flame retardants in circuit boards, similar chemicals also used in flux	Activators in flux
What is the current method for testing?	
EN14582: Oxygen bomb followed by ion chromatography	TM #2.3.28.1: Ion Chromatography
What are further pending industry questions?	
Does the use of halogen-free PCB materials impact end-product reliability?	Is halide-free actually more reliable than materials which contain halides?
Does the elimination of chemicals for environmental concerns limit the quality of electronics assemblies?	What is the best way to test fluxes for halide content?

Halogen-Free Standards

Standard	Pertains to:	Limits
IPC J-004B	Soldering fluxes for electronics assembly	Optional test: Max 1000ppm Cl or Br each to be considered low-halogen
IPC Halogen Guideline	Fluxes	Committee closed without disposition
JEDEC JS709A	Defining "Low-halogen" Electronic Products	Max 1000ppm Cl or Br each
IPC-4101B	Rigid and multilayer printed board base materials	Max 1500ppm total halogen or max 900ppm of either Cl or Br
IEC 61249-2-21	Materials for printed boards	Max 1500ppm total halogen or max 900ppm of either Cl or Br
JPCA-ES-01-1999	Test method for halogen-free materials	Max 1500ppm total halogen or max 900ppm of either Cl or Br

Halogen-Free Implementation Challenges for Fluxes and Solder Paste

- **Activity and Oxidation Barrier**
  - In order to solder, metallic surfaces must be free of oxides; fluxes provide this function
  - Activators and rosin/resin are flux constituents that remove oxides and protect surfaces from oxidation
  - Halogen-free chemistries require a higher loading of activators, leaving less space for constituents that provide oxidation protection
  - Reflow properties are challenging, with a higher propensity for graping along with increased sensitivity to high peak temperatures and long reflow profiles
- **Potential Reliability Challenges**
  - Targeting equal performance without halogenated constituents could mean higher concentrations of activator
  - Activators not consumed during reflow can increase the risk for electrochemical migration, SIR/ECM testing
- **Hole-fill on Thick Boards with Wave Soldering**
  - Pb-free alloys are challenging to wave solder, especially to achieve hole-fill on thick PCBs
  - Eliminating halogens in wave flux makes soldering thick boards even more challenging
  - Higher solids content materials possible
- **Testing Halogen Content of Wave Flux Residue**
  - Fluxes with low solids have very little residue
  - Halogen test requires 0.5-1.0g sample for oxygen bomb method

Sources of Halogens in Electronics and Impacts of Halogen Elimination

(in order from highest contribution)

- **PCB Laminate Materials**
  - Halogen-free alternatives are more expensive to manufacture and may be more sensitive in high-reliability applications
- **Components**
  - Halogen-free components are being developed, but design can be challenging in complex ICs
- **PBC (primarily in cables)**
  - Halogen-free alternatives are often more brittle and much more costly
- **Soldering Materials**
  - Halogen-free materials could suffer in soldering performance (HiP, graping, and sensitivity to long profiles)

From One Engineer To Another®

Form No. 98510 R3

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Halogen-Free Materials

All Indium Corporation solder pastes deliver high-quality performance:

- Consistent printing with long stencil life
- Unique oxygen barrier technology for exceptional halogen-free reflow
- Industry leading performance without adding halogens; none detected in industry standard test

Align your *focus* with your material choice!

- **Indium8.9HF** stable paste with consistent all-around performance
  - 1-year refrigerated storage life, stable at room temperature for a month
  - Wide process window to accommodate a wide variety of assemblies
- **Indium8.9HF-1** flux residues designed for best probe testing performance
  - Fewer false fails means quicker cycle times and less rework
- **Indium8.9HFA** stencil printing for miniaturized assemblies
  - Best transfer efficiency on fine features and at high print speeds
  - Very good performance in electro-chemical reliability testing
- **Indium10.8HF** next generation paste for high-warpage components
  - Eliminates non-wet open defects

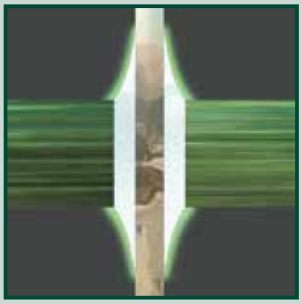
CW-802 and CW-807 Flux-Cored Wire

- Superior wetting speeds
- User friendly: low odor and smoke
- Halogen content of residue:
  - CW-802
    - Br < 10ppm • Cl < 10ppm
  - CW-807
    - Br < 10ppm • Cl < 10ppm

TACFlux®020B and TACFlux®089HF

- Performs well in traditional touch-up repair as well as BGA/CSP rework
- Halogen content of residue:
  - Br < 10ppm
  - Cl < 10ppm
- Low risk: passes SIR unreflowed (020B)

WF-7745 and WF-9945 Wave Solder Fluxes



- **WF-7745**
  - Superior hole-fill
  - No green copper discoloration as typical with VOC-free fluxes
  - Halogen content of residue:
    - Br < 10ppm • Cl < 10ppm
- **WF-9945**
  - Superior hole-fill
  - Sn/Pb and Pb-free compatible
  - Halogen content of residue:
    - Br < 10ppm • Cl < 10ppm

NC-771 Flux Pen

- Low risk: passes SIR unreflowed
- Halogen content of residue:
  - Br < 10ppm
  - Cl < 10ppm

Testing for Halogen Content

• Industry Standard Method

- **EN14582:** Oxygen bomb followed by Ion chromatography
  - Post-reflow flux residue is burned at high temperature, breaking covalent bonds, volatizing organics and leaving behind only halide ions and inorganics in the ash
  - Ion chromatography is run on the ash, providing a "true" identification of halide content for final assembly
  - Test must be performed on post-reflow flux residue (NOT solder paste, NOT raw flux)

Halogen Content

Test Item	Results (mg/kg) Sample #1420646	Detection Limit (mg/kg)
Chlorine (Cl)	ND	10
Bromine (Br)	ND	10
Fluorine (F)	ND	10
Iodine (I)	ND	10

• Unacceptable Methods

- **Ion chromatography (TM #2.3.28.1)**
  - Quantitative test
  - Separation of ions and polar chemicals to test the quantity of halide species in a flux
  - Detects only ionic halides, not effective in measuring covalent halogens
  - Many chemicals can cause false readings for halide content
- **Extraction of residues from board surface**
  - Quantitative test
  - Extraction is conducted on the board surface, but not only flux residues are extracted
  - Constituents from the board materials, components and surrounding areas are all collected and analyzed as one sample
  - Results indicate ionic residues on an assembly; further testing must be conducted to understand origin of ionic constituents
  - Detects only ionic halides; not for measuring halogen content
- **Silver chromate paper test (TM #2.3.33)**
  - Qualitative test only
  - Color change on paper indicates presence of chloride and bromide ions
  - Detects only halides, not quantitative at measuring covalently bonded halogens
- **Titration (quantitative)**
  - Quantitative test
  - Solution titrated to endpoint and chloride ion equivalents is reported
  - Detects only ionic halides, not for measuring halogen content
  - Many chemicals can cause false readings for halide content