Fume Extraction: Guide to Safely Managing Solder Fumes in the Workplace

Our thanks to OK International for allowing us to reprint the following.

Why do we need fume extraction?

Today's Electronics workplace contains numerous hazardous airborne substances, for example:

- Solder Fumes
- Adhesive Fumes
- Solvent Vapors

Solder Fumes

When solder flux is heated above 183^{o}C, a complex mixture of resin acid particulates (smoke) and gases are generated – this is called "COLOPHONY" and is produced from:

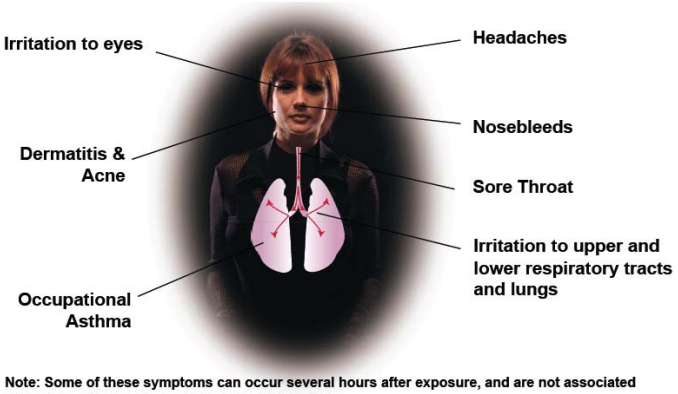
- Hand Soldering
- Solder Pots and Fountains
- Wave Solder machines
- Reflow Ovens

Adhesives and Solvents

When using adhesives and solvents, vapors are produced, for example from:

- PCB Cleaning
- Conformal Coating
- Adhesive Application
- Potting Compounds
- Other chemicals and solvents

Inhalation of hazardous fumes causes…



Note: Some of these symptoms can occur several hours after exposure, and are not associated with work. This is called a 'late asthmatic reaction'

Inhalation of hazardous fumes results in…

- Reduced productivity and absenteeism
- Re-recruiting and Re-training costs
- Operator compensation claims/litigation

Economic Consequences…

In the UK

- 2000 people every year develop occupational asthma
- 70,000 people believe they have asthma caused by substances breathed in at work
- Up to 25% of exposed operators develop occupational asthma
- £50 million in output and one million working days per year are lost due to occupational asthma

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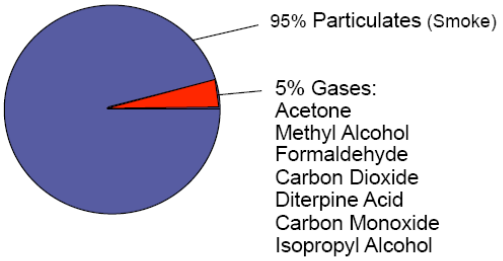
So why are solder fumes dangerous?

A typical solder fume is a mix of very small particles (smoke) and gases:



Even 'Synthetic' and 'No Clean' fluxes can lead to serious lung irritation

All of these can be removed with an efficient fume extraction system.

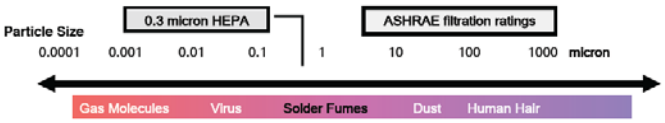
Implications of Lead Free Soldering

Flux Core in leaded Solder Wire
Is up to 1% of the density

Flux Core in Lead Free solder
is up to 3% of the density

- The higher % of flux content and increase in temperatures account for more fume than in standard solder wire.
- The higher concentration of activators in lead-free fluxes produces a more acrid and irritating fumes.

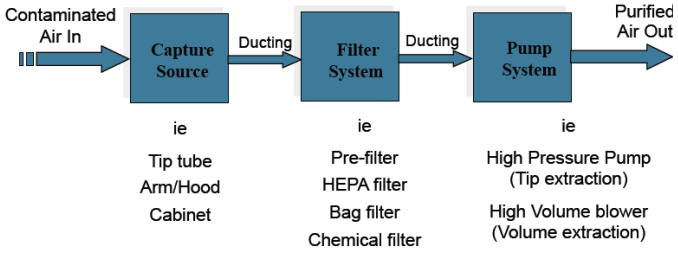
Fumes or Gases?



- Fumes are often thought of as gases, but solder fumes are actually particles in the 0.1 to 1.0 micron size range.
- Fumes are actually dust-like particles that are invisible to the human eye. 10 microns is the smallest visible, compared to the human hair at 100 microns.
- HEPA filtration is designed to remove fumes 0.3 microns and Larger.
- Gas Molecules will pass directly through HEPA Filtration.

How does a fume extraction system work?

All extraction systems work on the same principal:



Capture source - overview

- Tip Extraction
- Arm Extraction
- Plenums
- Cabinets

Capture source 1 – Tip Extraction

Main Advantages

- Most effective and economic method
- Removes fumes 'at source'
- Removes fumes when iron is at rest
- Easy to modify any make of iron
- Lightweight stainless steel tubes
- 5.6mm (0.2") to 12mm (0.5") diameter tubes available. Tube is easily adjusted

Main Disadvantages

- Requires regular operator maintenance
- Tube can 'sometimes' be a restriction
- Not always suitable for heavy soldering

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Capture source 2 – Arm Extraction

Main Advantages

- Most recommended for heavy soldering/ adhesives
- Larger capture area than tip extraction
- 50mm (2”) and 75mm (3”) diameter arms available

Main Disadvantages

- Only work within a defined area
- Requires larger air volumes then tip extraction
- Installations require larger ducting
- Approx. 3x the cost of tip extraction.

Capture source 3 – Bench Top Plenum

Main Advantages

- Ideal for multi-applications
- Easily moved

Main Disadvantages

- Requires large volume of air to provide efficient extraction

Capture source 4 – Cabinets

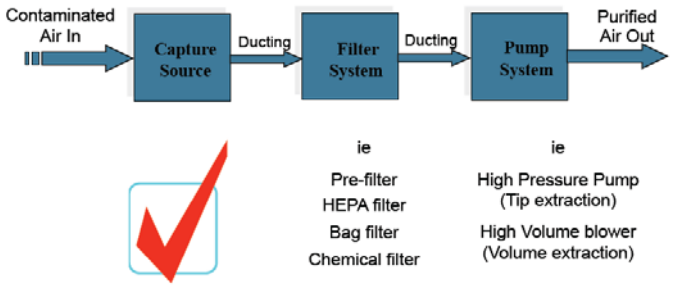
Main Advantages

- Ideal for multi-applications
- Self-powered
- Integral filters - with options

Main Disadvantages

- Can be too restrictive for some applications
- Cost per operator high

Ducting



How to connect them all up?

- With the exception of cabinets, Tip extraction, Arms and Plenums all require some form of connection.
- This is achieved by the use of ESD safe, push-fit, plastic ducting and couplings of various sizes, depending upon the type of extraction chosen:

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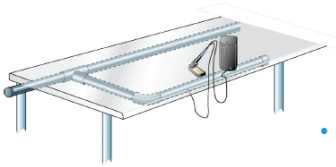
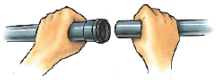
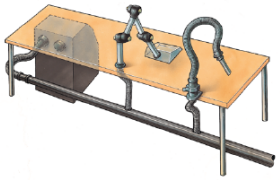
Installation Ducting and Piping

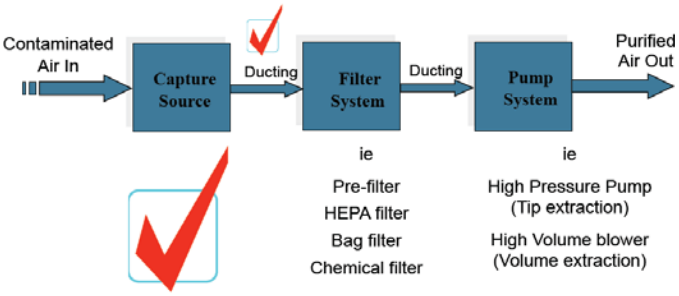




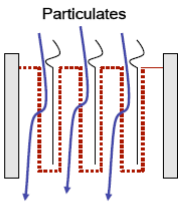


- Easy push-fit connections
- Easy to re-configure
- ESD safe ducting
- Installation service available
- Ducting Kits for Tips and Arms

Filters

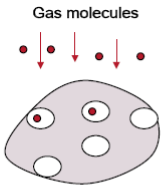


Filtration Principles



HEPA Filters

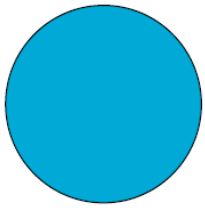
Particles are mechanically filtered by the filter media



Activated Carbon

Gas molecules are trapped inside the pores of the activated carbon

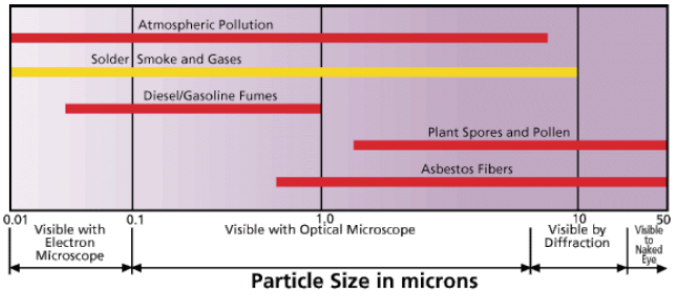
Understanding filter technology



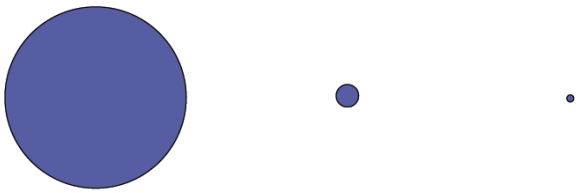
Human Hair = 100 microns **1 micron**

A micron is a unit of length which equals one hundredth of a human hair in diameter or one millionth of a meter.

- Filters are designed to stop debris (particles and gases)
- Everyday substances consist of different size particles:



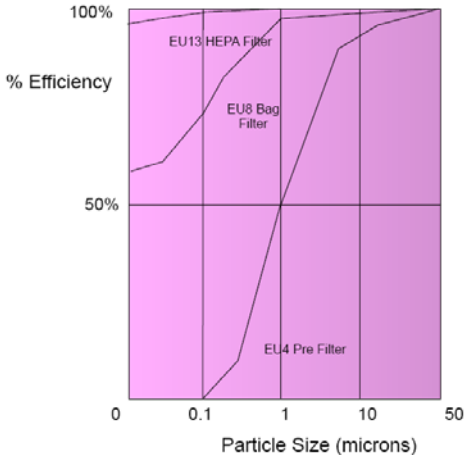
So, how big are SOLDER smoke particles?



100 microns diameter (Dia. Of Human Hair)

10 microns (Largest solder fume particle)

0.3 microns (Smallest solder fume particle)



Note:

All Particle filters are graded with a Eurovent Number from EU1 (Very Coarse) to EU14 (Very fine)

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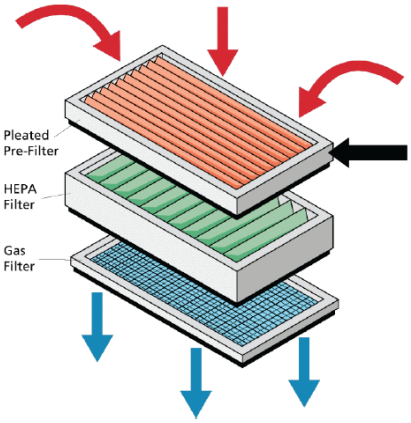
Pre-Filters

Pre-filters arrest large particles and protect the HEPA filter:

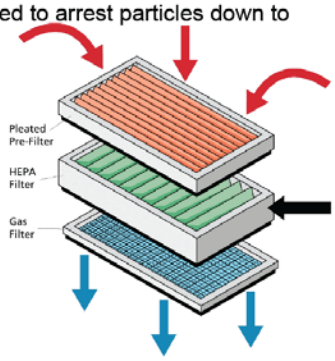


- Low cost
- Disposable
- EU4 Grade
- 50% efficient to 1 micron
- Pleated construction
- Synthetic media.

HEPA Filters

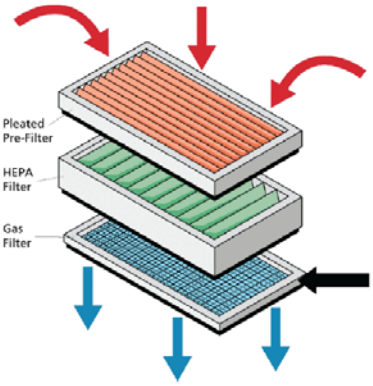
A HEPA filter is a very fine filter, it stands for High Efficiency Particle Air. The HEPA filter is fitted to arrest particles down to 0.3 microns:

- EU13 Grade
- 99.997 % efficient to 0.3 microns (95% to 0.01 microns)
- Class 100 (Federal Standard 209C)
- Mini-pleat construction
- Glass fiber media



Gas Filters

Gas filters 'soak up' vapors and gases…. e.g. Adhesive fumes



- Activated carbon...
- Specially impregnated to deal with many different chemicals
- Sintered construction
- Dust free
- Specials available
- Ideal for solvents etc

How long do filters last?

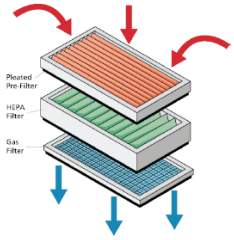
For soldering, this can depend on many things…for example:

- How many irons are on the system
- How many shifts are being worked per day
- How hot the soldering irons are
- What size tips are being used, etc…

FACT: Heavy soldering will block HEPA filters prematurely.

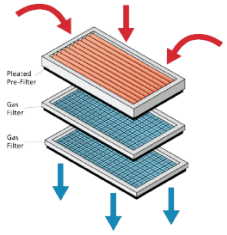
Filter options

Option 1



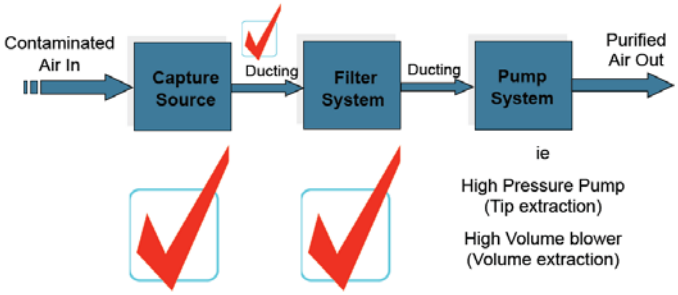
Pre - HEPA - Gas (for light/medium soldering)

Option 2



Pre - Gas - Gas (for solvent/adhesive fumes only)

Pump System



Understanding Pump Technology

There are two basic types of extraction pumps:

High Pressure
Side Channel Blowers

(at Low Volumes)

High Volume
Centrifugal Blowers

(at Low Pressures)

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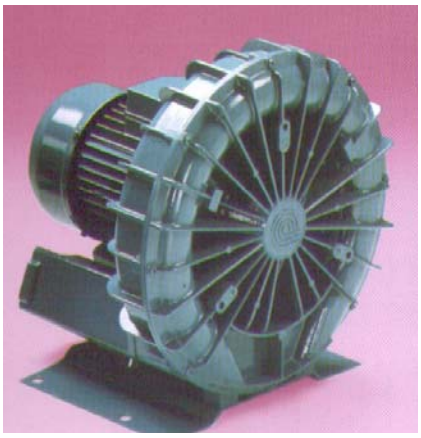
High Pressure Side Channel Blowers



An impeller directly coupled to a motor shaft provides the energy. The impeller has a large number of short radial blades enclosed in a die cast aluminum casing. This casing forms the side channel radially above and axially to the sides of the impeller blades. On the base of the casing the side channel is sealed off between the inlet and exhaust side and connected to the suction and discharge ports.

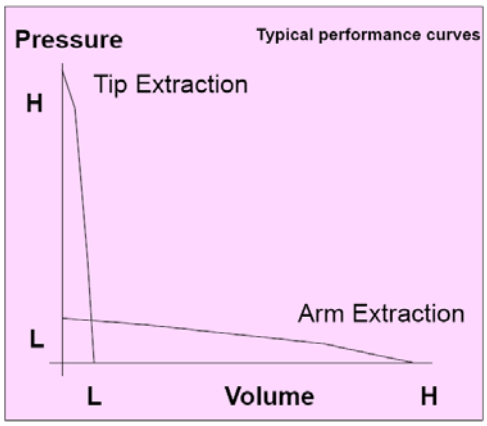
When the impeller rotates, the air between the blades is radially and circumferentially accelerated and there-by pushed into the side channel. Here it is compressed and forced backwards towards the impeller blades where it is again radially and circumferentially accelerated. The air is transported along a spiral path through the impeller and the side channel where it reaches the discharge port. At this point the air is expelled.

High Volume Centrifugal Blowers

An impeller directly coupled to a motor provides the energy. Air is drawn into an impeller wheel at the centre and thrown radially outwards into a “snail shell” housing. The air is then forced out via an exhaust port.

This type of pump generates very high volumes of air flow at low to medium pressures, however, nowhere close to that of side channel blowers.

What is the difference?



Tip and Arms CANNOT be mixed together.

Notes on Tip Extraction installations...

• Keep duct runs as neat and as unobtrusive as possible

• Keep the diameter of the ducting as *‘large as possible for as long as possible’*

• ALWAYS mount the ducting under the FRONT edge of the bench where possible

• ALWAYS keep the silicon hose as short as possible to avoid excessive pressure drops (no more than 1.2m (4’))

• Test system BEFORE drilling/tapping any extract points and test for leaks - you will hear them!

• Always position glands DOWNWARDS to avoid kinks in silicon hose

Tip Extraction Installation Faults…

• NEVER run ducting at the rear of the bench - On top or below

• NEVER join silicon hoses together to extend the reach–take the main ducting closer

• Always secure ducting at regular intervals to avoid unsightly drooping

• Always bridge duct spans of over 1.5 metres (5’) with a rigid support

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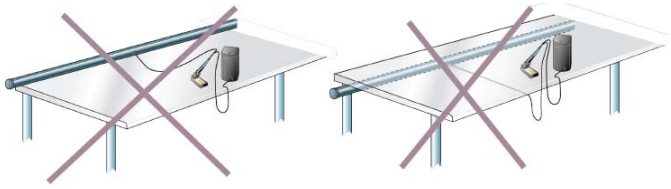
• Always leave cooling air space around the main pump system

• Never install ducting too small for the amount of irons required



Tip Extraction Commissioning...

• Using the Flow Meter, connect the iron end of the silicon hose to the TOP inlet port

• Switch on the system and read the centre of the ball on the meter - it MUST be over 28 litres/min for 5.6mm tubes

• Check ALL irons on the system

• Check system ducting for leaks

• Check the pump system filter seals and lid seals

• Make a drawing/floor plan of the installation (LEV record) and record the measurements. Date and file for future reference.

Operator Maintenance Checks - Tip Extraction

To ensure good continuous performance of Tip Extraction systems, the following checks should be made at regular intervals as needed. Failure to carry out these simple tasks could result in premature failure of the system.

• Clean iron tubes with brass wire cleaning brushes supplied as required

• NEVER allow the tube to become totally blocked

• Replacement tubes can be fitted quickly and cleaned out at the end of a working shift

• Clean the under bench gland as required

Notes on Arm Extraction Installations

• Keep duct runs as neat and as unobtrusive as possible

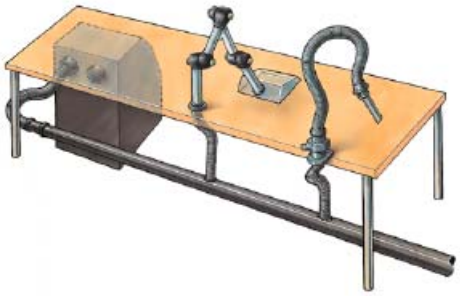
• Keep the duct runs as SHORT as possible and avoid too many bends

• Always use BOTH ports on the system if fitted and fit a ‘ring main’ if possible - Always use 75mm diameter ducting or larger

• Never exceed more than 5 x 32mm or 4 x 50mm arms on one 75mm duct run - this will dramatically reduce performance

• Test system BEFORE drilling any extract points and test for leaks – you will hear them!

• Try and site the pump system central to the installation where possible



Arm& Cabinet Commissioning...

• Using an Anemometer, offer the probe up to the face of the opening in the arm/hood/cabinet

• Switch on the system and read the VELOCITY on the meter scale - it should not be below 10m/s for arms, or below 0.5 m/s for hoods and cabinets

• For cabinets and large openings, take 12 readings and take the average

• Check ALL arms/plenums on the system and check the system ducting and pump unit/filters for leaks

• Make a drawing/floor plan of the installation (LEV record) and record the measurements. Date and file for future reference.

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