

## THE PURPOSE OF FUME EXTRACTION

Soldering work involves both metallic and organic compounds. The solders themselves contain, besides tin and lead, various levels of zinc, arsenic, cadmium, antimony and other metals. Fluxes necessary for soldering contain activators to enhance their cleaning properties; these activators are typically organic acids. Such compounds, when heated, release byproducts of incomplete combustion, which in turn can contain noxious fumes, particulate matter, aerosols, and gasses. Prolonged breathing of these contaminants can lead to both short- and long-term operator irritations and illness. Respiratory tract irritation, sore throats, eye irritation and headache are the most common symptoms. Allergies and asthma are often exacerbated by solder smoke.

Please note that the metals of which solder is made do not themselves vaporize at soldering temperatures. Lead, the metal with the lowest vaporization temperature commonly found in solders, does not become a gas below 2950 degrees F. What you are really getting rid of, and what you want to get rid of, is flux smoke. Scorched board material and conformal coating are extra added attractions.

### Types of flux.

1. **Resin-based.** The oldest, most popular and still most effective soldering flux. This flux is an organic compound consisting primarily of colophony, a complex resin found in pine trees. The active agents in resin flux are *abietic acid* and *plicatic acid*; it is the reaction between these organic acids and metallic oxides on the joint materials that provides the cleaning required for solder to 'wet' the joint. In a world free of stickybeaks and activists it would be sufficient to inform operators that these organic acids, when exposed to soldering temperatures, combine with oxygen and yield products of partial combustion which may be irritating to the skin and eyes, or exacerbate respiratory problems. Abietic acid may also cause skin irritation at room temperature - some people are unable to hug a pine tree - and there is some correlation between colophony and allergic reactions.

Some resin-based fluxes contain additional chemical activators, usually organic fatty acids, which help the fluxing process along by making the compound even more acidic than usual. This helps soldering, to be sure, but may add even more irritants to the air.

Resin-based flux leaves a residue behind, after the soldering operation is finished. This residue must be cleaned from the board, both to allow further operations (such as conformal coating) to be carried out with a minimum of fuss and bother, and for cosmetic reasons - charred flux is abominable in the eyes of an inspector. Isopropyl alcohol & methyl alcohol are the solvents of choice; they are cheap, effective, and quick. Cleaning, alas, requires an increment of time, and 'unproductive' time at that; alcohol fumes are unpleasant to some; we therefore have a choice of:

2. **'No clean'.** These fluxes do not, in theory, require cleaning after use, for they do their work and vanish under the influence of heat. Some of them are organic and some are not; most if not all of them are more active - that is,

more acidic - than their resin-based predecessors, and all exude chemical residues and products of partial combustion that are even more likely to irritate sensitive membranes than those derived from trees. Many soi-disant 'no clean' fluxes are organically based, usually on an alcohol, and have a low solid content. Typical constituents of solder smoke from no-clean fluxes arise from the breakdown of alcohols and include ethane, acetone, formaldehyde, toluene, terpenes, carbon monoxide and carbon dioxide and, of course, alcohol fumes. Whoo!

Some water-based no-clean fluxes have been developed; they do not produce the volatile organic compounds peculiar to alcohol-based fluxes, though their use entails special equipment to preclude splattering and continuous testing to verify the acid concentration. Such fluxes are extremely active and should be handled carefully to avoid severe skin irritation.

3. **Water-soluble fluxes.** These fluxes are designed to wash away from the board and components with plain, ordinary water, and sometimes they do that. Carboxylic acids ( $R\ COOH$ ), relatively weak organic acids, are primary constituents of many water-soluble fluxes, along with a detergent (called a 'surfactant' in the trade) and, of course, water. Both the acid and the detergent can produce irritating fumes.

Water-soluble fluxes are usually washed off with hot water; occasionally a saponifier is added to help the cleaning process. Saponifiers are alkaline, and may be corrosive; they react with the acid residue on the board to form a soap and glycerine, which is relatively easy to wash away in hot water. Fumes are not the problem in the wash process; splatter is.

You will have noticed, no doubt, that most soldering fluxes are organic compounds that break down under heat, and emit objectionable fumes of one sort or another. The chemical reaction between the acid in the flux and the oxides on the board contributes to the release of fumes, though the compounds thus generated are but a small part of the total.

FLUX: From Mediæval Latin *fluxus* fr. Latin *fluere*, to flow. (5) A substance used to promote fusion (as of metals or minerals), *specially* one (as rosin) applied to surfaces to be joined by soldering, brazing or welding to clean and free them from oxides and promote their union.

Lead particles will transfer themselves from the solder to the skin; that is why soap was invented.