Concept & Guidelines for Process Fume Filtration

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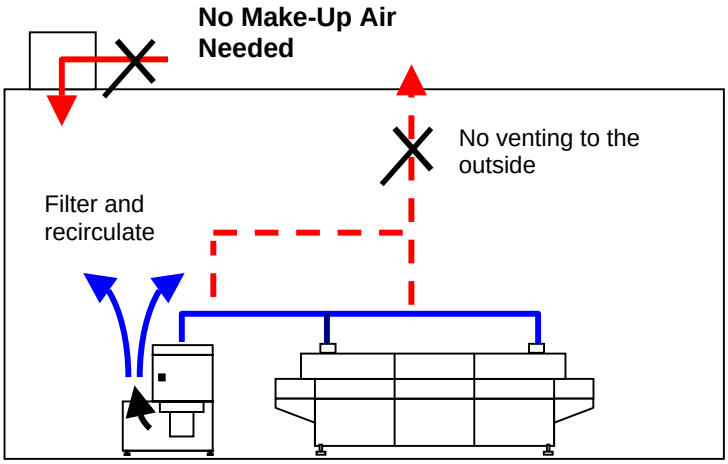
1. CONCEPTS AND BENEFITS

Concept

Traditionally exhaust from wave solder machines, reflow ovens, aqueous cleaners and other process equipment has been vented to the outside. Our filter units offer an alternative: filtration of the exhaust and recirculation. This concept has been applied in the electronics industry for close to ten years. It is gaining broader acceptance as it resolves a range of issues that are inherent to venting to the outside, and as it offers major benefits to a fast-paced production environ-ment.



Short Production Start-Up Time

When installing a new circuit board assembly line, providing the necessary exhaust can be one of the most time consuming steps. When venting to the outside, this phase requires coordinating with outside contractors, engineering the duct layout and altering the facility (cutting holes in the roof, installing duct, roof vents, fans). This process can take weeks and represents a considerable cost for each piece of equipment. Additionally, venting exhaust to the outside requires costly and time-consuming EPA-permits and environmental impact studies, which are sometimes required for each rooftop vent.

These time-consuming steps are not required when using an air purification system to filter and recirculate exhaust. To install a filter unit takes only a few hours and requires no facility alterations or environmental permits.

Flexibility

The ability to move an assembly line in a short period of time at a low cost is critical. At the time of a layout change, filter units move with the line. No additional cost is incurred due to the relocation of an assembly line. The alteration of fixed ducting can require days or weeks, and represents a substantial cost and delay each time a line is relocated.

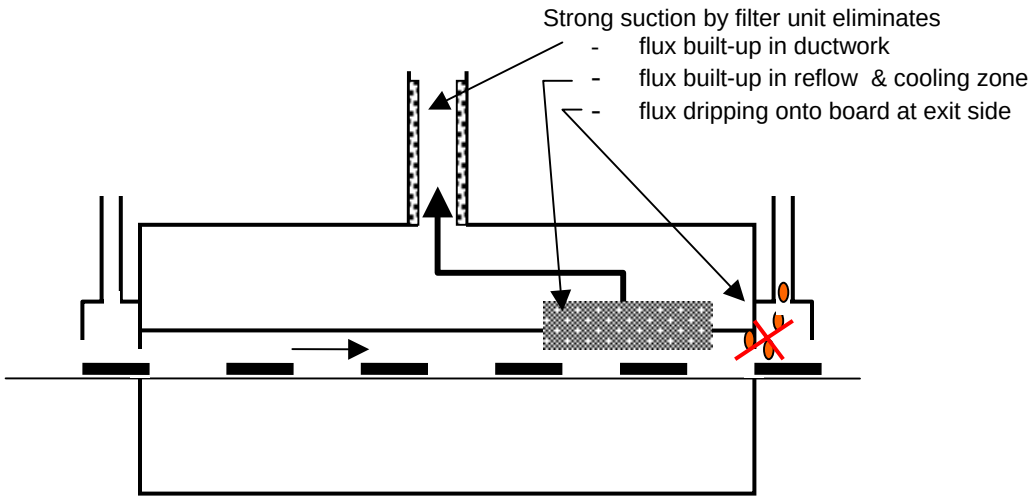
ISO14000 Certification / Environmental

The electronics industry is one of the first industries aggressively adopting ISO14000 standards. These standards call for the management and reduction of environmental pollutants, predominantly in water and air. Filtration and recirculation has become a major stepping-stone for achieving ISO14000 certification. Our filter systems eliminate air pollutants and can help companies achieve “zero” discharge facilities. ISO14000 certification and the philosophy of being an environmentally friendly company significantly improve the corporate image.

Improved Process Control

The amount of air exhausted from ovens and waves can affect thermal control. If too much air is drawn from the process, heat loss occurs. If the venting process does not draw enough air, the flux fumes are not properly vented and can cause

- heavy flux built-up inside the ducting which again reduces the venting process
- additional flux built-up inside the oven which will lead into more frequent oven maintenance
- Flux drippings onto boards at the exit side



A dedicated filter unit provides more consistent airflow, enhances the process control and can reduce maintenance costs.

Reduction of Facility Maintenance Costs

In a large electronics production facility, maintaining ductwork can easily occupy a full maintenance department. Common maintenance problems when using central exhaust systems are:

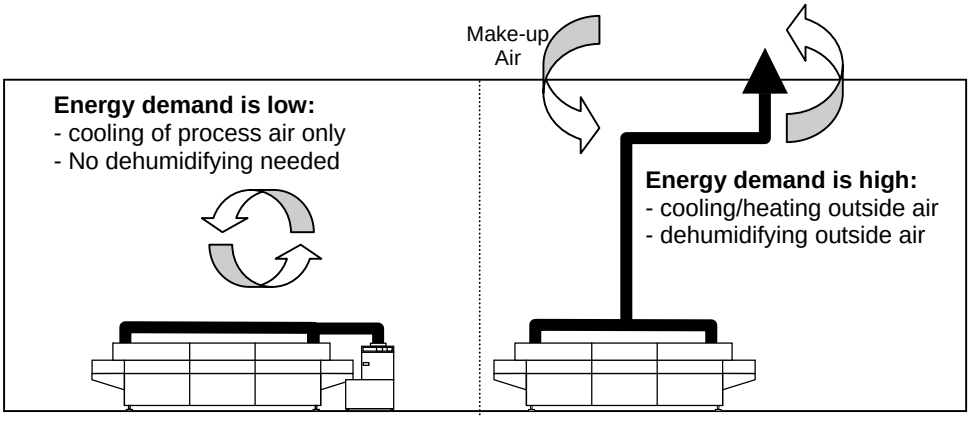
- air-balancing problems; inadequate ventilation of remote process equipment
- not enough HVAC capacity for make-up air when adding new lines
- cleaning of clogged ducting from dross dust and rosin settlements to maintain adequate airflows
- repairing roof leaks at duct penetrations of the roof

No Alterations to Rented Facilities

At the end of a lease, a tenant is generally required to remove/repair all alterations to the rented building. This represents a major cost upon move-out, as ducting & roof fans must be dismantled, and roof holes must be repaired. It may also be a problem for a tenant to get the property owner's approval for such alterations in the first place. Filtration and recirculating requires no facility alterations and eliminates this problem.

Heating and Cooling Costs

A common perceived disadvantage of filtering and recirculating exhaust is that the exhaust heat is retained inside the building and therefore greatly increases HVAC costs. This is an incorrect conception, often based on the comparison of exhaust temperature and facility room temperature.
When assessing the heat impact of filtration and recirculation, *the temperature <u>and the humidity level</u> of the process air must be compared to the temperature <u>and the humidity level</u> of the make-up air* (from outside).



Filtration & Recirculation Venting to Outside

Any air vented to the outside of a facility has to be replaced with make-up air from the outside. When venting 1,000 cfm from a wave solder machine to the outside, the air conditioning system has to supply the plant with 1,000 cfm of "make-up air" to maintain the balance inside the building. Therefore, the energy or heat impact of filtration and recirculation is the difference between cooling process air from inside the facility or cooling/heating make-up air from outside.

The make-up air from outside needs to be cooled and dehumidified while the recirculated air from a filter unit needs to be cooled only.

Savings are achieved in two ways:

- lower installation costs due to a reduced air condition capacity
- lower operating cost due to operating a lower aircondition capacity

These benefits become even greater when maximum daily outside temperatures exceed 35 C degrees in which case the outside air is very often warmer than the recycled process air. In regions with very cold temperatures, significant heat savings can be gained from the warmer recirculated air during winter periods.

Based on the analysis of an independent engineering company the following operating savings can be achieved. **Details of the study can be supplied upon request.**

Annual Energy Savings for 1 line (1 wave and 2 ovens):

Savings:	**Tampa**	**Dallas**	**Chicago**
AC equipment savings	14 tons	11.5 tons	10.3 tons
Annual energy savings (heating & cooling)	87,000 kwh	155,000 kwh	272,000 kwh
$ Based on average of 7.5 cents/kwh	$ 6,525	$ 11,625	$ 20,400

Negative Air Pressure
It is very common in production facilities that air is vented to the outside at a greater rate than can be brought back into the facility. This condition results into a negative air pressure and causes several adverse conditions as

- Worker draft complaints
- Natural and mechanical ventilation reduced
- Possible carbon monoxide hazard as back drafting will take place in hot water heaters, unit heaters, furnaces and other combustion equipment not provided with induced draft
- Doors difficult to open, etc.

Air Quality inside Facility
When venting contaminated process exhaust to the outside, it is typically discharged on top of the roof -- which in most cases is in close proximity to air intake vents of the air-conditioning units. Depending on wind conditions, contaminated exhaust air can drift to the fresh-air intake shafts and be returned into the facility. The result is a degraded air quality inside the plant. This common hazard is eliminated when filtering and recirculating exhaust air with purification systems. In contrast, HEPA filtration of the air reduces overall particle count in the facility.

2. Air Quality Verification

Numerous independent industrial hygienist studies were conducted to test the quality of the filtered and exhausted air. The test results showed that lead levels and most other monitored contaminations are well below detectable limits after filtration. **Details of a study available upon request.**

Particle counts indicate that our filter units constantly reduce the overall dust load inside of a production facility.

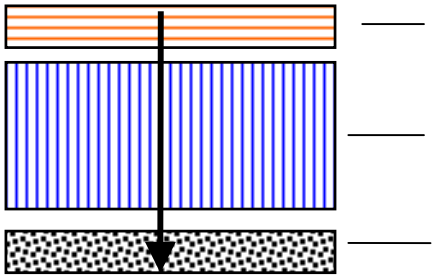
Should there be any doubt regarding the air quality, we recommends to employ independent hygienists to test and verify the actual conditions.

3. Application Specific Filtration Methods

The filtration of air includes two methods:

- Particle (dust and fumes) removal
- Gas filtration which is the removal of vapors from solvents, etc., or other gases in "molecular" form

Our filter units apply both methods and contain a multi-stage filtration as shown in the schematic below:



Pre-filter: Removes majority of the air contamination; 30 to 60% efficiency ratings; low cost

HEPA filter: High efficient particulate air filter; in most cases 99.97% efficient at 0.3 micron; removes all fine particulates; efficiency is higher than a Class 100,000 clean room filter

Activated Carbon: Filters gases ranging such as formaldehyde, solvent vapors, MEK, and many other substances

Optional **after-filters** can be supplied with the F8200 series. These filters further reduce the particle count in the exhaust which may be helpful in semi-cleanroom application conditions.

Depending on the application the filters may vary in size and efficiency. Most applications in the electronics industry require heavy particle filtration and while some require predominately a "gas-phase" filtration.

Guideline for Filtration Method

Application	Air Contamination Levels		Filtration Method		
	Particulate	Gases	Pre	HEPA	Carbon
Hand solder fumes	moderate	low	yes	yes	moderate
Reflow / Curing	moderate	low	yes	yes	moderate
Wave solder w/ flux based on alcohol	high	moderate	yes	yes	moderate to high
Wave solder w/ flux based on water	high	none	yes	yes	not needed
Conformal Coating	moderate	moderate to high	yes	yes	high

Equipment Selection Matrix

The selection matrix below is intended as a guideline for equipment selection. We have the ability to mix and match a number of varied filter and system configurations based upon each clients specific applications and needs.

Application	Model	Airflow	Power / Motor Rating	Connection Flanges
Filter Units with standard combination filtration: Pre / HEPA / Gas • Rework Soldering • Reflow Ovens • Curing Ovens • Selective Wave Solder • Wave Soldering	F3200C	600 cfm	110VAC – 60Hz / ¾ HP	Unit has two air inlets 6” dia.
	F8220C	900 cfm	230V – 3 Phase 2 HP	AC1002 Dia 10”
	F8230C	1400cfm	230V – 3 Phase 3 HP	AC1002 Dia 10”
	F8240C	2000 cfm	230V – 3 Phase 5 HP	AC1003 Dia. 14”
Filter Units with HEPA and high-capacity gas filtration: Pre / HEPA / deep-bed Gas • Selective Conformal Coating • Spray fluxers	F3200PG	500 cfm	110VAC – 60Hz / ¾ HP	N/A
	F8220PG	600 cfm	230V – 3 Phase 2 HP	AC1017 Dia 8”
	F8230PG	900 cfm	230V – 3 Phase 3 HP	
Filter units with deep-bed gas filtration and explosion safe design High concentration levels of flammable vapors	F3002GX	500 cfm	230V – 3 Phase ¾ HP	N/A
	F8220GX	600 cfm	230V – 3 Phase 2 HP	AC1017 Dia 8” (202mm)

4. Considerations and Limitations

Limitation to Applications: There are some applications in the electronics industry where a filter unit cannot reduce the air pollutants to desired levels or would cause unacceptable high amounts of filter replacements. These applications include:

Use of Foam Fluxers: Wave solder unit which use foam fluxers evaporate alcohol in too large amounts to be filtered. We recommend to vent the exhaust of foam fluxers to the outside.

Conformal Coating Spray Booth: When applying conformal coating with spray guns, the amount of mist generated is large and will clog up filters rapidly. These fumes should be vented to the outside.

Wave Solder Applications: When filtering the exhaust of wave solder units with spray fluxers, low levels of Isopropanol are emitted back into the facility. The alcohol can be smelled direct in the air stream of the exhaust but in general not at a distance of 1m from the exhaust. The levels have been traditionally well below safety levels. They can be noticed as the odor threshold for Isopropanol is only 40 ppm while the safety level is 400 ppm.

For better filtration in high production environments, we recommends the use of separate filter units for the exhaust from the solder wave and for the exhaust from the fluxer. In this case the filter media capacity to absorb the alcohol can be significantly increased. See Application Matrix above.

Proper duct installations: To assure a proper venting of the oven or wave solder unit duct installations need to be done according general engineering principles. “Bottle-Necks” such as combining two ducts into only one duct of same size need to be avoided.

Fresh-Air Exchange: General engineering principles for fresh air-exchange need to be followed. While our filter units can reduce the amount of make-up air needed, it is important that fresh air intake is maintained. Facility design criteria in the USA call for a “fresh air” intake of 20 cfm / person or approx. 33 m3/h.

Ventilation Design: When filtering and recirculating air, heat from the application process is remaining inside the facility. Exhaust air temperatures average approx. 90 Deg F for wave applications and 110 Deg F for ovens. While the additional heat may be of benefit in winter periods, it needs to be cooled down in the summer. However, keep in mind that the air conditioning capacity needed for this is much lower than the capacity needed for make-up air.

Reduce make-up air from outside and convert some of the AC capacity for cooling of inside air.