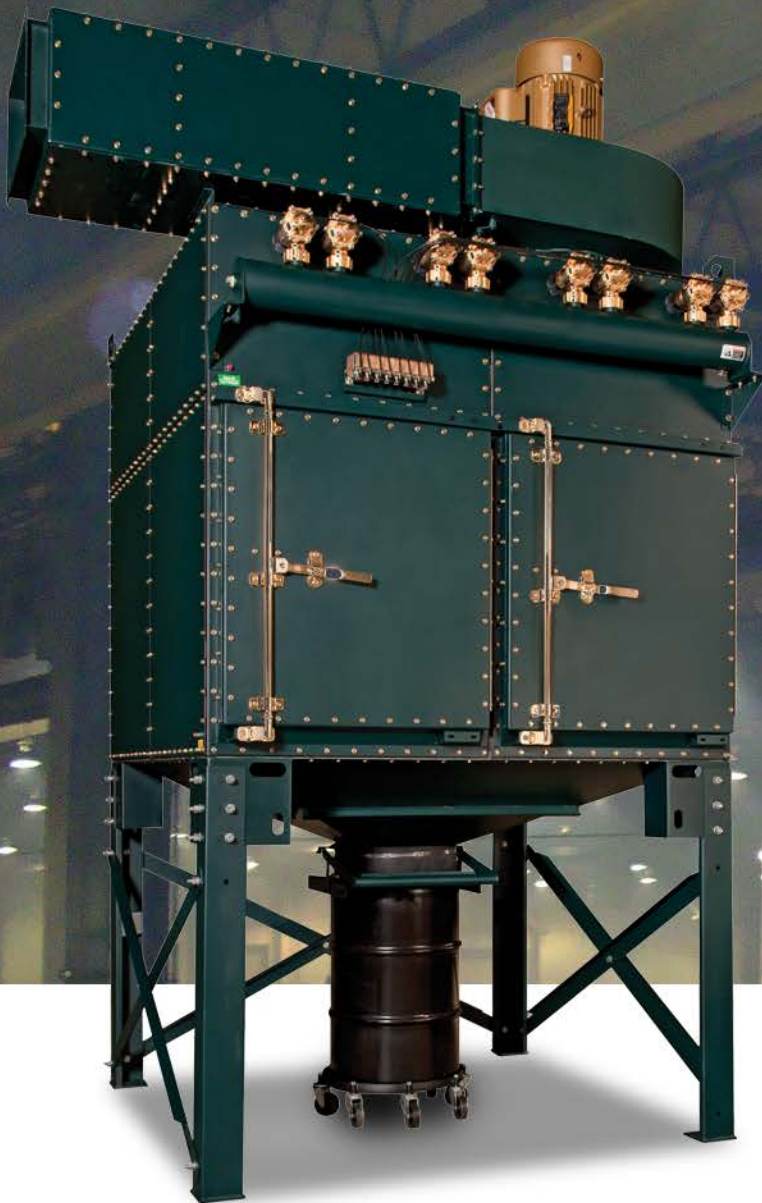


WHITE PAPER

Welding Fumes: Are They Out of Control in Your Shop?

This white paper will help you to recognize when your fume extraction equipment isn't working properly, the detrimental effects when this occurs, and what to do about the problem.



By Jon Ladwig and Greg Schreier

 **camfil**
AIR POLLUTION CONTROL

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Keeping welding fumes to a minimum in the shop is essential for protecting people, property and productivity. This white paper will review some of the leading signs or indicators that your weld fume extraction equipment is not working properly; the detrimental effects to your employees and your business when this occurs; and basic steps you can take to address the problem.

Common Signs of Fume Extraction Equipment Malfunction

Assuming you have some type of collection/ extraction system in place to capture weld fumes, one or more of the following conditions will signal that this equipment is not doing an adequate job:



Though some degree of visible fumes will occur during welding, a dense fume cloud signals that the extraction system is not doing its job.

1) Visible fume and dust emissions: Some degree of visible fumes is inevitable during welding; but with a properly functioning extraction system, you should only see fairly light fumes through most of the shift. For example, in an ambient system that filters all the air in the shop, a light cloud may be visible during working hours but dissipate during break times or lunch when work ceases. If the cloud grows denser and denser throughout the day, there is probably an issue. It may be that you've outgrown the fume extraction system because of increased production, that it was improperly sized at the original time of installation, or that the equipment is malfunctioning.

2) Worker complaints: Welders complaining of health and discomfort problems are likely being exposed to an excessive level of fumes. Weld fumes are linked to a startling array of both short- and long-term health effects which are summarized in the next section of this article. Complaints should always be taken seriously and addressed as promptly as possible.

3) Failure to meet established air quality standards: Air quality testing using air sampling techniques is often performed to ensure that a shop is in compliance with OSHA regulations. OSHA has established permissible exposure limits (PELs) based on 8-hour time weighted average for hundreds of dusts, including the numerous metals contained in welding fumes. For further information, a good starting point is the OSHA Fact Sheet, "Controlling Hazardous Fume and Gases during Welding" (https://www.osha.gov/Publications/OSHA_FS-3647_Welding.pdf). By the time a shop fails an air quality test, heavy fume clouds and worker complaints will already be in evidence.

4) Premature plugging of filters and related equipment issues: If the filters in your fume extraction system are failing prematurely and requiring frequent change-out, the culprit may be excessive airflow for the filter media area. The collector may be too small for the job, or the filter

pulse-cleaning system may not be working properly. The diaphragm and solenoid valves that regulate pulsing are critical for proper cleaning to occur, so proper valve operation is something to monitor during preventive maintenance inspections.

The compressed air system is another potential source of trouble. If compressed air pressure is too low, the pulse cleaning system will not clean the filters properly. If the compressed air moisture content is too high, filter plugging or solenoid and diaphragm valve problems may result. Moisture problems in compressed air systems are especially prevalent when equipment located outside in winter climates experiences below freezing temperatures.

Damaging Effects of Malfunctioning Equipment

As noted previously, overexposure to weld fumes caused by equipment malfunctions can cause a wide range of health problems.

- **Metal dust particles** in welding fumes are an eye irritant and a leading cause of eye injuries in factories.
- **Manganese**, the primary metal in welding wire, can cause workers to feel exhausted, apathetic, weak or headachy. Chronic overexposure to such fumes leads to a condition known as “manganism”, which is characterized by neurological and neurobehavioral health problems.
- **Hexavalent chromium** or **hex chrome** is a carcinogenic substance produced during welding or other types of “hot work” on stainless steel and other metals that contain chromium. Hex chrome overexposure can result in short-term upper respiratory symptoms, eye or skin irritations. Long-term, the greatest health danger associated with hex chrome exposure is lung cancer. Other major health effects include damage to the upper respiratory system, and allergic and irritant contact dermatitis. Respiratory tract problems can include inhalation damage to mucus membranes, perforation of septum tissue between the nostrils of the nose, and damage to the lungs. In addition, there may be injury to the eyes, skin, liver and kidneys.

Once in the body, hex chrome typically targets some of the body's organs. A worker exposed to hex chrome may also experience symptoms such as sinus irritation, nosebleeds, stomach and nose ulcers, skin rash, chest tightness, wheezing and shortness of breath. The current OSHA PEL for hex chrome is extremely stringent, at 5.0 µg/ m3 (micrograms per cubic meter).



This weld shop uses a recirculating system that recycles clean air through the workplace downstream of the fume extraction process. It has been independently tested to produce emissions far below OSHA Personal Exposure Limits (PELs) for the metals contained in welding fumes.

- **Zinc oxide** is a pollutant generated by hot work on galvanized steel. Exposure can result in a condition known as “metal fume fever”, a short-term illness in which severe flu-like symptoms occur after a break from work, such as after a weekend or during a vacation. Due to the delayed reaction, it is often confused with regular influenza and many cases go undiagnosed.
- **Welding fumes** can also cause headaches. A factory employing 60 welders received daily complaints of headaches from the workers. The problem disappeared upon installing an ambient fume removal system.

It is imperative to know and follow OSHA exposure guidelines for these and other metals, particularly where workers are at risk for long-term health effects.

But employee health is not the only concern. Welding fume or “smoke” consists of hot dust particles that rise to the ceiling. What most people don’t know is that these particles lose their buoyancy when they cool, falling to settle on floors, desks, office equipment, furniture and paperwork. No one wants to work in a dirty shop.

Machinery in the shop also suffers when weld fumes and dust get out of hand. Virtually every piece of equipment today – welding machines, cranes, robots, plasma cutters, etc. – contains a computer. When metal dust accumulates on sensitive electronic componentry, it can cause premature failure due to overheating and short circuiting. Equipment control cabinets with computers often have multiple small cooling fans on which dust buildup can cause reduced airflow as well as fan failures. This, in turn, leads to increased repair bills and costly, unexpected downtime. Fume and dust buildup in electrical power components can also cause arc flashes which are extremely dangerous and potentially fatal to personnel.

The “Ins” and “Outs” of Fume Removal

In the past, when weld fumes became excessive, the simple solution was to open the shop door and exhaust the fumes outside. Due to today’s more stringent EPA regulations, that is no longer an option. If visible fumes are exhausted outdoors, the air is subject to stringent monitoring under EPA National Emission Standard for Hazardous Air Pollutants (NESHAP) Rule 6x. This rule went into effect in 2011 and is highly applicable to welding shops.



Air sampling pumps and filters worn by workers in an emissions test are used to monitor indoor pollutant levels to determine whether the shop is in compliance with OSHA.



This integrated safety monitoring filter prevents collected dust from re-entering the workspace if there should be a leak in the dust collector's primary filtering system.



A high efficiency cartridge dust collector with top mount motor fan and silencer reduced floor space requirements and installation costs in this welding shop.



Example of a well-designed fume extraction system using high efficiency filtration, a custom ducting layout, and curtains to help contain contaminants within the process area.

The collector may also require safety monitoring filters (also called after-filters) for added filtration and backup protection.

If you factory air is conditioned, air recirculation is the single best way to save energy and maximize return on investment with a dust collector. By recirculating heated or air conditioned air back through the plant instead of venting it outdoors, the cost to replace that conditioned air is eliminated. Facilities in all regions report five- to six-figure annual energy savings, with the greatest savings seen in northern climates which experience longer, colder winters. In addition, the U.S. Department of Energy offers public utility-sponsored rebates and incentives for facilities that used recycled heated or air conditioned air.

Within this standard are materials that contain 0.1% by weight cadmium, chromium, lead, or nickel; or 1.0% by weight manganese. Manganese is the material of widest concern to the welding industry, as it is virtually a universal component of welding wire.

Under the new EPA guidelines, if you opt to exhaust the air straight outdoors, you must take an EPA Method 22 Fugitive Emission test. Method 22, which is conducted to provide a visual determination of fugitive emissions from material sources, is performed by a trained observer who observes an exhaust stack during a 15-minute timed test. If opacity – defined as the quality of a particle that makes it impervious to light – is observed during 20 percent or more of the test (i.e., three minutes), Rule 6x applies. Involvement of an environmental engineering consultant is recommended to conduct the Method 22 test and provide third-party confirmation of whether a facility is in compliance.

What actions are necessary if Rule 6x applies and a company has failed the Method 22 test?

1. Notify the EPA.
2. "Tier 1" response: Change the process to eliminate the HAP. This might be accomplished by experimenting with different materials and/or different settings to reduce emissions. Whatever changes are made, equipment must always be operated in accordance with manufacturer's instructions.
3. Conduct another Method 22 Emissions test.
4. "Tier 2" response: If the second test fails, "Corrective action must take place immediately after the failed Method 22 test" per the Federal Register, page 42985, Welding compliance, Tier 2.

If air is contained indoors rather than exhausted outside, it is subject to OSHA requirements as above.

The role of cartridge dust and fume collection

Whether you opt to exhaust air outdoors or recirculate air indoors, one strategy that offers multiple benefits is the use of a dust and fume collector with high efficiency cartridge filtration. Cartridge filtration is identified under Rule 6x as an acceptable control device to eliminate visible emissions, and will in many cases be the solution of choice.



Robotic weld cells are equipped with individual hoods and ducting. A central fume extraction system keeps the area clean while providing the needed mobility.

A well-designed cartridge system will properly filter welding fumes and other hazardous contaminants, and the filtered air can either be exhausted outside or recirculated back into the facility for significant energy savings. These systems use self-cleaning mechanisms that pulse dirt off the filters, allowing units to run for extended periods between filter change-outs.

There are three general types of cartridge dust and fume collection systems used to clean up welding processes:

a) Source capture systems are popular for applications involving small parts and fixture welding. They will typically utilize a flexible source capture arm or a complete enclosure around the operation, such as an enclosure around a robotic weld cell.

b) Canopy hoods are often utilized if the footprint area is a medium size such as 12-ft x 20-ft or less. Curtains or hard walls may

be added to the sides to create a booth or enclosure, although the ability to use such barriers may be limited by workspace requirements or the presence of other equipment or processes in the area.

c) Ambient systems that filter all the air in the shop using a central system or multiple smaller collectors are often chosen to serve larger areas because they allow a facility involved in multiple operations to capture all the fumes.

Being proactive about weld fume control

There are several other proactive steps you can take to ensure that your fume extraction equipment is doing the best possible job.

- **Schedule regular inspections and perform periodic service.** Verify that dampers are in position, valves are working and pulse cleaning systems are functioning properly. Check pressure drop on filters to make sure it has not exceeded the manufacturer's recommended limit. Check compressed air pressure and purge the compressed air header, looking for

signs of moisture. If you are located in a cold climate, make sure that your compressed air has a dew point that is below the lowest temperatures your equipment will be exposed to.

- **Test your dust.** If you're having issues or complaints, bring in an environmental engineer to perform air sample testing. This will allow you to pinpoint what pollutants are occurring and to determine whether you are below OSHA PEL thresholds. Also, if you haven't tested your dust for flammability and explosivity, NFPA guidelines call for you to do so. An environmental engineer or your fume collection equipment supplier can connect you with a lab that specializes in explosion testing.
- **Find a qualified equipment supplier.** If you are performing preventive inspections and basic maintenance but still encountering problems, chances are the fume extraction system is undersized or inadequately designed for the application. Bring in an air pollution control supplier who is experienced in welding filtration system applications; who is knowledgeable about OSHA, NFPA and EPA requirements; and who has the technical resources to develop an engineered solution to the problem. This supplier should also offer a full range of equipment so as to offer unbiased advice on the right type of system for your shop.

Conclusions

Keeping weld fumes under control is needed for regulatory compliance; but as we've seen, that is not the only reason for taking action. There are countless documented cases of workers who are healthier and more productive when the indoor air is clean of fumes, with reductions experienced in a wide range of symptoms from headaches and nasal congestion to more serious and chronic long-term illnesses. Good indoor air cleaning also prevents buildup of nuisance dust on electrical components, machinery and employee work stations, a common occurrence that can interfere with everyday operations.

In recent years, we have seen an increasing number of larger companies in hot work operations setting their own guidelines for dust and fume exposure – guidelines that are sometimes far more stringent than OSHA PELs. These companies are voluntarily testing and monitoring exposure to ensure compliance with their own self-imposed air quality goals.

Though it may not be practical for every shop to initiate such a program, taking a proactive approach to weld fume control will still enable you to have a positive impact on your workers' health– while avoiding the fines or shutdowns that can result from non-compliance. When you add energy savings from air recirculation to the equation, you achieve the trifecta of compliance, health/wellness and energy savings.

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Camfil APC is a global manufacturer of dust, fume and mist collection equipment and is part of Camfil, the largest air filter manufacturer in the world. For further information, contact 800-479-6801 or 870-933-8048; e-mail filterman@camfil.com, or visit www.camfilapc.com.