Welding Processes Pose Tough Challenge for Fume Filtration

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Welding fumes pose unique problems for fume filtration systems. Understanding six key factors can help shop owners pick the right one for their facility.

Welding fumes place a greater demand on filtration systems than any other application in industry. A casual approach to air filtration can be harmful to the health of workers and the business.

The fumes and particulates generated by welding demand more from filtration than practically any other application in industry. Ironically, filtration for welding is often treated casually, with shop owners regarding it as a D-I-Y ("do it yourself") project.

This is not to say that custom-built systems aren't appropriate, but simply an admonition that there are factors specific to welding environments that make a casual approach to air filtration harmful to both the health of workers and the health of the business.

Consider these facts:

• The National Institute for Occupational Safety and Health (NIOSH) classifies welding fumes as potential occupational carcinogens [NIOSH 1992].

• The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned welding fumes a threshold limit value (TLV) of 5 mg/m^3 as a Time Weighted Average (TWA) for a normal 8-hr. workday and a 40-hr. workweek.

• Exposure to welding fumes from mild steel is associated with the development of a benign pneumoconiosis, "arc welder's siderosis."

• Stainless steel contains nickel and chromium, both of which are known to cause cancer if exposure exceeds maximum allowable levels over an extended period of time.

• The welding arc can form ozone and nitrogen oxides. MIG and TIG welding make the most ozone, most of all when aluminum is welded. These fumes irritate the eyes, ears, nose, and throat, and can damage the lungs unless proper air filtration is used.

Finding the Best Solution

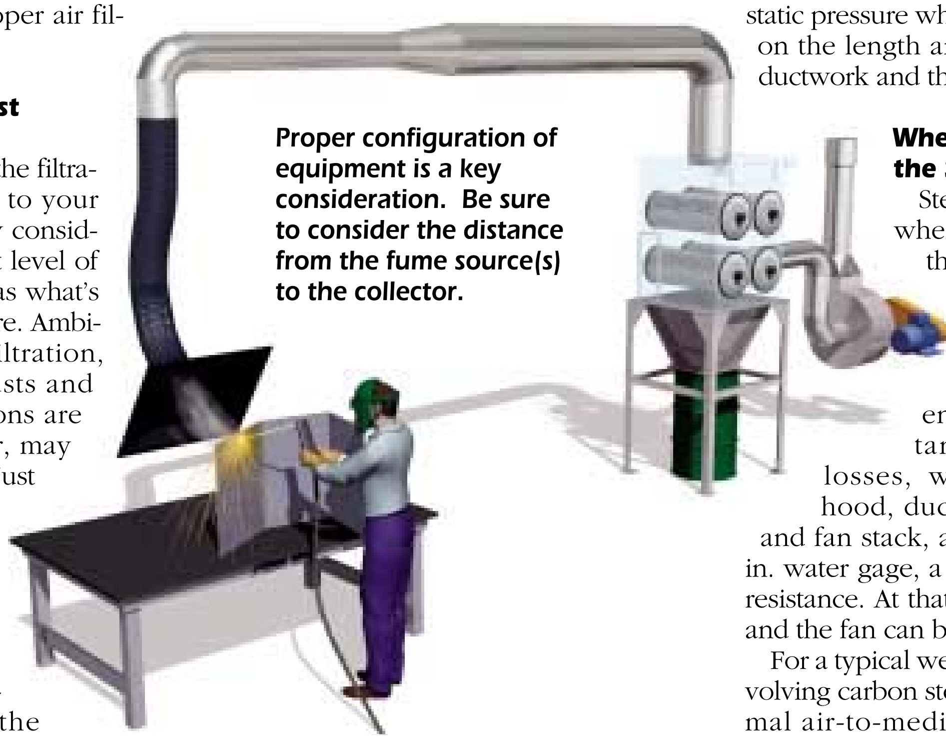
To determine the filtration best suited to your facility, begin by considering the current level of activity, as well as what's likely in the future. Ambient air intake filtration, where plant dusts and welding emissions are filtered together, may suffice if there's just one welding operation, and welding is incidental. Where welding is multi-station or ongoing, source capture, through the use of an air intake hood system in close proximity to the workstation, will be needed to be effective. By "effective," we mean capable of capturing, efficiently and consistently, both fumes and heavier particulates. The second part of being "effective" is that the device can do its work for extended periods, and without creating a maintenance issue.

If source capture is required, the first step is to quantify the airflow required to draw fumes and fine particles away from the welder. As a practical matter, to collect all particulates would require such a huge airflow that it would detrimentally affect the welding process. So, the largest particulate will not be extracted. The collection of fine particles and the fumes that OSHA regulates is the mission.

Configuring Equipment

The second step is to configure the equipment. The distance from the source(s) to the collector is key. Will one collector serve multiple hoods? If so, duct losses will increase, and the airflow required for efficient collection will rise.

The capture velocities required to collect the material and the sizing of the ducts transporting the material relate to the development of static pressure, the airflow required with the proper horsepower to achieve proper draw. This is the most critical calculation, and the single most important reason why filtration is generally not a simple weekend D-I-Y.



Proper configuration of equipment is a key consideration. Be sure to consider the distance from the fume source(s) to the collector.

The annual Industrial Ventilation Conference has a course that covers hood design, hood sizing and its relation to ductwork, the conversion of velocity pressure to CFM, and other factors. Many community colleges have similar programs. Probably the best reference book in the industry is the Industrial Ventilation manual. It can be obtained by attending the conference or through the American Conference of Governmental Industrial Hygienists in Cincinnati, OH.

It was recommended earlier that shops consider future requirements right from the start. The reason is that any addition of equipment, or increase in the distance between system components, necessitates revision of the design. Systems designed with a fan operating at a given RPM will produce a given cfm against a given static pressure. Change any element of this equation and you change everything else. The airflow required to achieve a given result rises or falls based on static pressure which, in turn, is based on the length and diameters of the ductwork and the size of the hoods.

Where to Place the System

Step three is to decide where it all fits. Assume the room is 30 ft. long, and the collector and one welding station are installed at opposite ends. Given this distance, the system losses, which include the hood, duct, elbow, collector and fan stack, are calculated at 8.0 in. water gage, a measure of air flow resistance. At that point, the collector and the fan can be properly sized.

For a typical welding application involving carbon steel material, the normal air-to-media ratio is approximately 2.0 to 2.5:1. That is 2 to 2-½ cfm of air for every one $ft.^2$ of media. If we use 3,000 cfm and divide that by the air to media ratio (2.5), that produces a requirement for 1,200 $ft.^2$ of filter media.

That value is then divided by the square feet of media in the filter (assume 226), and the result will indicate a requirement for 5.3 cartridges. Since five is not a normal option and most cartridge collectors are normally configured in sets of two, the correct recommendation would be to use six cartridges, in order to avoid the higher, and somewhat less effective, air-to-media ratio. The smaller number is always preferable; in this case, the ratio becomes 2.2:1.

Selecting a Collector and Cartridge

Step four is to select a collector, and cartridge type. There are many suppliers that manufacture equipment to control weld fumes. Once a collector is chosen, the cartridge style can be selected. Standard "full packs" with a 12.75 in. o.d., 26 in. long, and 226 $ft.^2$ of media are widely used throughout industry for collecting weld fume particulate.

Determining the Most Effective Media

Step five is to determine the most effective media. Welding fumes may involve coatings which can be heavy and/or oily. Because the fumes (particulates) contain oil or moisture that has not fully combusted, the particulate will appear sticky or wet and is absorbed into the media. A moist cartridge cannot perform properly. To prevent this, media used for welding can be pretreated with diatomaceous earth or amphorous aluminum silicate. These materials prevent moisture from being absorbed by the media and blinding it. It will also assist in the release of the particulate during the pulse cleaning cycle.

Dirty Air Pretreatment

Where there are several workstations, and large quantities of oily material, there is another solution; the pretreatment of dirty air before it reaches the cartridge. With this method, the welding air stream is injected automatically upstream of the cartridge with the selected pre-treat material. The powder encapsulates or attaches itself to the particulate, making it drier and more amenable to filtration.

Proper pretreatment can extend the life of the cartridge. Longer life means less frequent shutdown for cartridge replacement, and less solid waste disposal volumes. The pretreatment material, which is used sparingly, is relatively inexpensive (about $1.00/lb. on average).

Dealing with Coatings

Better coatings technology has eliminated some oily material problems at their source. Hot-dipped galvanized material has always been toxic when welded, and that's just a given. But stainless material, fortunately, is no longer coated with lacquer, historically a troubling source of welding emissions. As coatings technology has improved, however, metal quality has often moved in the opposite direction.

Steels and other metals from China, Tajikistan, and similar locales may be alloyed differently. They are also more likely to be coated with an unidentified rust prohibitive and contaminated with various organic and inorganic matter. If the metal is sourced from the secondary market, questions loom even larger. The bottom line in either case is that the composition of the fumes coming off the welding operation is likely to be unidentifiable.

Thus, the choice of filter media becomes more important. Various types of cellulose-based media can be used, but a blended media of cellulose and polyester for welding applications has several advantages.

Proprietary Resin

Airguard encapsulates its blended media fibers with a proprietary resin that makes it resistant to moisture, even before pretreatments are applied. Originally engineered for gas turbine inlet filtration, it excelled, in terms of both performance and longevity, in this harsh environment. This media provides fast recovery from extended exposure to moisture, and is also cost-effective.

An equally important advantage of blended media over 100 percent cellulose is greater structural integrity. Welding presents formidable challenges to filter media relative to pressure drop. As the cartridge gets dirty, pressure rises across its face and the more it rises, the more RPMS and horsepower are required to achieve the target airflow.

Since the RPM of the fan is constant once a higher pressure drop is reached, and the cartridge has reached its maximum expected level of pressure drop, airflow (cfm) drops, velocity at the hood is diminished, and the system is no longer effectively extracting all the fumes and dust.

Stronger media are more resilient to the mechanical stresses of particulate accumulation, pulse cleaning, and humidity. Cellulose, on its own, will far more readily absorb moisture, thereby compromising filter integrity by warping and collapsing. Without polyester fortification, cellulose fibers that are exposed to welding fumes and particulate will weaken and deteriorate.

Concern with Inefficiency

Step six is to forget "efficiency" and consider its opposite. Inefficiency is what you're really concerned with. A cartridge that's 99.99 percent efficient for a given particle size is also .01 percent inefficient. It doesn't take a large system to leave significant quantities of particulate circulating in the building's HVAC system or being discharged to the atmosphere.

The math is compelling, and to illustrate, we'll cite a small example: A system of 6,000 cfm, multiplied by 60 minutes in an hour, times one shift of 8 hrs. equals 2.88 million $ft.^3$ of air. Using that volume of air multiplied by the grains per cubic foot (assume 1.5 $gr./ft.^3$) of dust collected, you have collected approximately 617 lbs. of dust. If the filtration is 0.01 percent inefficient you're left with .0617 pounds of dust per day, every day, in your system. Extrapolate that into a normal work year of approximately 250 days, multiplied by the .0617 and you have 15 lbs. of dust somewhere in your building or system.

Conclusion

Regardless of the metallurgy of the part, the coatings protecting it, or the contaminants on it, the most appropriate filter media for welding applications should efficiently collect particles 0.5 microns and larger. The filter that tests highest at meeting that specification and providing a long service life, is a cellulose/polyester blended media cartridge.

The high tensile strength of the blended fiber, coupled with the proper pleating and cure process used by the manufacturer, gives these cartridges exceptional strength and collection efficiency, while maintaining proper airflow. Used in a properly maintained and adjusted pulse jet-system, blended media have one of the longest service lives of any commercial cartridge.