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Clean up with the Three Cs: Capture, Carry, Contain

Fig. 1 — Portability is one of the prime benefits of individual weld fume source capture systems such as the one shown here.

Details are provided on the three primary steps toward cleaner plant air

BY LaJEAN LARSEN

Dirty shop? Slippery floors from accumulation of welding fume? Employees breathing suspected carcinogens? These are only a few of the many good reasons to clean up your shop air.

Cleaner air in the welding shop, manufacturing plant, or thermal spray operation helps operators to avoid breathing injurious fumes, helps prevent hazardous spots on floors, and helps keep surrounding equipment clean and functioning. Collecting fume, removing it from the air, and directing clean air back into the plant is one of the best ways to work toward a cleaner plant. This article discusses three steps toward cleaner plant air.

Capture

Basically, there are two ways to capture welding fume, overspray, dust, and other airborne particulate: ambient collection and source capture.

Ambient Collection

Ambient collection can be successful in maintaining low concentrations of fume, mist, or dust, but it usually is only employed when source capture is not feasible. Ambient collection involves one or more ceiling-mounted fume collectors that clean the surrounding air via filtration then discharge the cleaned air back into the workspace.

The primary advantage of an ambient collection approach is that it is inexpensive; however, there are several disadvantages to this form of capture.

1. Since the circulation of filtered air is above their heads, welders, who are bent over their projects, continue to breathe in a concentration of fume produced during welding.

2. Ambient systems only clean a minimal portion of a room's volume at any given time. Depending on the airflow, it may take days or weeks to clean and recirculate all of the plant air.

3. Ambient systems are inefficient and incur more energy usage because the system must run constantly to be effective for the volume of plant/room air being treated.

Source Capture

Source capture is the most effective way to capture the largest percentage of weld fume, dust, and mist. This method employs capture hoods positioned properly at the welding area to capture the fume, mist, or dusts. Ducts then carry the

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Fig. 2 — When installing a unit to collect fume from several welding stations, get the proper sized ductwork, collector, and fan.

fume, mist, or dust away. One or more collectors are used to filter the contaminants from the air so it can be returned to the plant.

Typically, a capture hood is positioned 12–18 in. from the weld area, such that the fume is taken immediately away before passing through the worker's breathing zone. Hood positioning and the distance from the hood face to the weld are critical. The welder must be diligent in keeping the hood close to the weld to be effective. If the hood is repositioned twice as far from the source, it will take four times the air to provide the same capture performance for the same fume.

In a source capture system, the typical capture velocity at the welding zone is 150 ft/min for low toxicity welding. This low velocity is sufficient to ensure that the fume and smoke particles are captured. For a flanged typical hood with a cross-section open area of around 2 ft^2, the flow requirement would be approximately 1320 ft^3/min.

While the initial cost to implement a source capture system is believed to be the primary disadvantage to this capture method, there are several advantages to this method. With the proper hood design and positioning, and with good quality filter media in the collector, high cleaning efficiency can be achieved with little or no accumulation of potentially combustible dust on surrounding surfaces. Also, using one collector for each weld station will lower energy costs because the collector and fan may be turned off when the station is not in use. And, finally, welders will breathe cleaner air because the hood captures the fume before it has an opportunity to get into the welder's breathing zone.

Source capture systems, such as individual weld fume collectors, can be effective with a single fume collector servicing each weld station — Fig. 1. These collectors are typically portable, allowing greater adaptability for different uses. They consist of a compact fume collector with an adjustable arm for optimal positioning above the weld point.

Another approach is to install a larger collector connected to several weld stations (Fig. 2); however, sizing the ducting, collector, and fan to appropriately fit the

Understanding MERV Ratings

Since the late 1990s, the minimum efficiency reporting value (MERV) rating system based on ASHRAE Standard 52.2-1999 has been deemed the most accurate scale for determining a cartridge filter's initial efficiency and ability to filter submicron dust particles. MERV ratings illustrate a filter's efficiency based on particle size (Fig. 3), whereas previous standards measured efficiency based on particle weight. Why the change in standards? Because the testing equipment has improved and MERV ratings became possible. More manufacturers today need advanced filtration technology such as Donaldson Torit's Ultra-Web® to capture smaller submicron particulate (0.3–1.0 micron). MERV ratings that indicate efficiency based on particle size pinpoint a filter's efficiency in capturing smaller dust particles with much greater accuracy.

Independent lab tests of Ultra-Web, cellulose, and blended media have revealed differences in the MERV efficiency ratings for the various types of filter media. For instance, Ultra-Web filter media rates at a MERV 13 on the 20-point efficiency scale, and is considered a pre-high-efficiency particulate air (HEPA) media suitable for filtering submicron and larger dust. Typical blended media filters have a lower MERV 10 rating and some cellulosed media filters rate lower at MERV 8 efficiency. This is important because MERV 10 filters are rated to capture dust particles in the 1 to 3 µm size and MERV 8 filters are only rated to capture larger 3–10 µm size particles. Since nearly every application generates some submicron dust, a higher MERV-rated filter provides better assurance that smaller particles are being captured, along with the larger ones. Bottom line — your air is cleaner.

More MERV May Not Always Be Better

While MERV 13 meets the efficiency demands of most applications and there is little difference between the efficiency of MERV 13 and MERV 15, some applications do call for higher efficiency. The company makes higher performance filters to meet those demands. However, there should be some caution exercised when choosing a filter with a MERV rating higher than 13. While delivering higher initial efficiency, filters with ratings greater than MERV 13 can have shorter filter life and consume more energy due to higher pressure drop during pulse cleaning. Therefore, the cost savings benefits can be less as filters may need to be replaced more often.

The MERV Comparison Table

Group	Std 52.2 MERV Ratings	Composite Avg. Particle Size Efficiency (PSE)			Particle Size Ranges	Average Dust Spot Efficiency Std 52.1	Average Arrestance byASHRAE 52.1 Method	BIA	European Efficiency Class	Typical Filter Type	Typical Control Contaminant
		(E_1) 0.3 - 1.0µ	(E_2) 1.0 - 3.0µ	(E_3) 3.0 - 10.0µ							
5	20				≤ 0.30 µm	N/A	N/A	H		**HEPA/ULPA Filters** ≥ 99.999% efficiency on 0.10-0.20 µm particles, IEST Type F	**≤ 0.30 µm Particle Size** Virus (unattached) Carbon dust Sea salt All combustion smoke Radon progeny
	19							H		≥ 99.999% efficiency on 0.30 µm particles, IEST Type D	
	18							H		≥ 99.99% efficiency on 0.30 µm particles, IEST Type C	
	17							H		≥ 99.97% efficiency on 0.30 µm particles, IEST Type A	
4	16	≥ 95%	≥ 90%	≥ 90%	0.30-10 µm	80-95%+	>98-99%	H	F9	Membrane Technologies Nanofiber Technologies Ultra-Web	**0.30-1.0 µm Particle Size** All bacteria Most tobacco smoke Droplet nuclei (sneeze) Cooking oil Most smoke Insecticide dust Copier toner Most face powder Most paint pigments
	15	85%-94.9%	≥ 90%	≥ 90%				M	F9		
	14	75%-84.9%	≥ 90%	≥ 90%				M	F8		
	13	**≤ 75%**	**≥ 90%**	**≥ 90%**	**0.30-10 µm**	**80-95%+**	**>98-99%**	**M**	**F7**		
3	12	—	80% – 89.9%	≥ 85%	1.0-3.0 µm	40-75%	>95-98%	M	F6	Spunbonds (10-12) Fiber Blends (8-10) Cellulose (8-10) 3M Filtrete™ (11)	**1.3-3.0 µm Particle Size** Legionella Humidifier dust Lead dust Milled flour Coal dust Auto emissions Nebulizer drops Welding fumes
	11	—	65% – 79.9%	≥ 85%				M	F6		
	10	—	50% – 64.9%	≥ 85%				M	F5		
	9	—	< 50%	≥ 85%				M	F5		
2	8	—	—	70%-84.9%	3.0-10.0 µm	<20-35%	80-95%	L	G4	Fiber Blends Cellulose Panel Filters Dust and pollen Filters Furnace filters	**3.0-10.0 µm Particle Size** Mold Spores Hair spray Fabric protector Dusting aids Cement dust Pudding mix Snuff Powdered milk
	7	—	—	50%-69.9%				L	G4		
	6	—	—	35%-49.9%				L	G3		
	5	—	—	20%-34.9%				L	G3		
1	4	—	—	< 20%	>10.0 µm	<20%	60-80%	L	G2	Metal Foam Panel Filters Fiberglass	**> 10.0 µm Particle Size** Pollen Spanish moss Dust mites Sanding dust Spray paint dust Textile fibers Carpet fibers
	3	—	—	< 20%				L	G2		
	2	—	—	< 20%				L	G2		
	1	—	—	< 20%				L	G1		

Fig. 3 — The minimum efficiency reporting value (MERV) rating system determines a filter's efficiency based on particulate size.

job is the key. A central system is typically located outdoors with ducts running to each welding station. This allows many users to utilize the same dust collector. Each station will have either rigid ducts with a fixed extraction hood or an adjustable fume arm that can be used to position the extraction hood to increase capture efficiency.

Carry

Effectively carrying the fume to the collector is the next step. When removing fume, mist, and dust, "effectively" means having an airflow strong enough to keep airborne particulate moving, so it cannot drop back down the hood or somewhere inside the ductwork.

For typical weld fume applications, where fume enters the duct above the hood, you need to maintain a minimum transport velocity of 2500 ft/min to ensure there is no drop out of fume in the duct.

To ensure adequate airflow is maintained in any system, choose a collector with a fan that exhausts a volume sufficient for all weld stations at once. Begin with this simple formula: Q = VA

Q = VA [ft^3/min = Velocity x Area]

Example: If you know you need 2000 ft^3/min, and you want to maintain 2500 ft/min in your duct, then 2000 ÷ 2500 = 0.8 ft^2 (12-in. duct).

On the reverse, if you have a 12-in. duct and you want to maintain 2500 ft/min, you have 2500 × 0.7854 = 1964 ft^3/min.

Work with your dust collector supplier to select an appropriate sized collector. Tables of various ducts are available in the industrial ventilation manual, *Ventilation and the American Conference of Governmental Industrial Hygienists*, and will be helpful in selecting duct components. Visit *www.acgih.org/home.htm* for more information.

After installation, check the actual system air flows and record the various static pressures measured at key system points. Then, over time, recheck the static pressures to ensure the system is still functioning properly.

Contain

The final key to good containment or fume removal is a high-efficiency filter. The three most commonly used types of filters for weld fume include

- Static filter systems;
- Electrostatic precipitators; or
- Self-cleaning collectors with cylindrical filters.

Static systems simply collect the fume-laden air. These filters are not designed to be cleaned and reused; instead, the dirty filters are simply replaced. Static systems, therefore, rely on low fume levels to allow reasonable filter life.

Electrostatic precipitators (ESPs) work well initially, but the collection efficiency diminishes as dust accumulates on the plates and charging wires prior to cleaning. ESPs can fill up quickly and be hard to clean. It is also worth noting that ESPs must typically be oversized in order to maintain a reasonable efficiency prior to servicing.

Self-cleaning fume collectors with cylindrical filters offer the most performance advantages for the containment/filtration stage. The collector is sized for constant airflow and the cylindrical filter contains ample filter media, which holds high quantities of fume particles. While fume particles are typically small — less than a micrometer (μm) in size — high efficiency filter media can capture these particles. This type of fume collector is capable of using compressed air to automatically self-clean. The operator just sets a differential pressure switch to activate the cleaning when a preselected differential pressure is reached. The cleaning mechanism runs only when needed.

In the End

Welding procedures and metals may produce toxic fume. You want the exhaust air coming out of the fume collector to be as clean as possible, especially if you are retuning the air into your workspace. Remember the three Cs — capture, carry, and contain — to provide a cleaner work environment for increased worker comfort, safety, and productivity.◆

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