Energy Saving Tips for Ducted Weld Fume Systems

Four weld fume system design improvements yield energy cost savings

BY ED RAVERT

The system's collection hood should be located as close as possible to the point of weld fume generation to reduce the volume of air required to collect the fume. Positioned directly over a process, this type of swing arm can be used in combination with a fume collector or stand alone.

The design and location of a weld fume dust collection system's hood, ducting, collector, and fan can collectively add sufficient static pressure requirements to the point where larger, more expensive to operate motors are necessary to maintain effectiveness. Optimizing these areas can make it possible to use smaller, more energy efficient brake horsepower motors. The electrical savings potential for a simple ducted weld fume dust control system is at least $1800 per year, and significantly more for larger systems.

System Design Improvement Areas

Hood Design/Location

Bell mouth-shaped hoods (Fig. 1), with an entry loss coefficient factor of 0.04, are ideal for energy savings. In comparison, plain, or raw edge collection orifices (Fig. 2), have a factor of 0.93. At a velocity of 2500 ft/min, the velocity pressure (VP) of the duct has a factor of 0.39. With a bell mouth hood, the water gauge static pressure (wgSP) is 0.41 in., or 1.00 + 0.04 × 0.39. The plain opening design requires 0.75 in. wgSP, or 1.00 + 0.93 × 0.39 for an increase of 0.34 in. wgSP.

Additionally, the collection hood should be located as close as possible to the point of weld fume generation to reduce the volume of air required to collect the fume. If the fume generated is 12 in. from the hood opening, a volume of 1000 ft^3/min might be required. But, if the hood opening is 24 in. away, the required ft^3/min volume increases as the square of the distance to 4000 ft^3/min.

Duct Design

The air velocity needed to carry collected weld fume is an important consideration. If the collected fume can be conveyed at 2500 ft/min (where VP = 0.39), it would be a mistake to convey them at 4000 ft/min (where VP = 1.0). At 2500 ft/min, the fume friction factor is 0.015 VP/ft of duct (0.015 VP × 100-ft = 1.5 VP × 0.39 = 0.23 in. SP). At 4000 ft/min, the fume friction factor is 0.019 VP/ft of duct (0.019 × 100-ft = 1.9 VP × 1.0 = 1.9 in. SP). The slower speed saves 1.67 in. of wgSP.

Ducting with a well-designed branch entry of 30 deg has a factor of 0.18, whereas a 45-deg branch entry has a 0.28 factor. At 2500 ft/min, VP = 0.39 (0.28 × 0.39 = 0.11 wgSP) for the 45-deg branch. In comparison, the 30-deg branch entry only requires 0.18 × 0.39 = 0.07 in. wgSP for a savings of 0.04 in. wgSP.

Duct elbows with a 1.5 diameter radius can have a factor of 0.24. A 2.0 duct elbow radius can have a factor of 0.19. Using the same factors as above, the 2.0 diameter radius will save 0.02 in. wgSP.

Added up, the total savings gained from well-designed ducting for a simple weld fume collection system is 1.67 + 0.04 + 0.02 for a total of 1.73 in. wgSP.

Dust Collector Operation

If the dust collector can operate with

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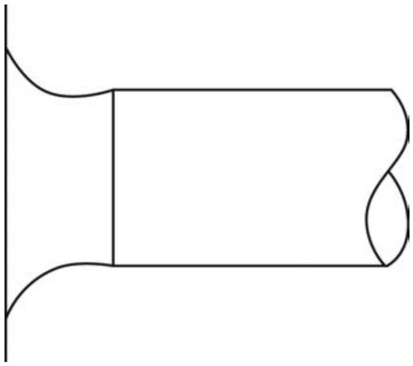

Fig. 1 — Bell mouth-shaped hood is good for energy savings.

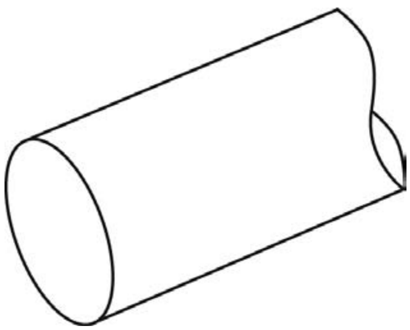

Fig. 2 — Plain or raw edge collection orifice.

nominally dirty filters at 4 in. wgSP, instead of the more common 5 in. wgSP, a savings of 1.0 in. wgSP can be achieved.

Additional savings can be obtained using a Photohelic® gauge to control the pulse-jet cleaning cycle in place of the traditional Magnehelic® gauge that keeps the compressed air on all of the time. Controlled cleaning with a Photohelic gauge not only saves compressed air and its associated energy costs, it also extends filter media life.

Fan Ducting

Bad things can happen if the ducting in and out of the fan is not properly designed and installed. Poor design is to install a two-diameter 90-deg radius duct elbow right at the fan inlet. This serves to add 1.0 in. VP. With inlet velocity at 4000 ft/min, 1.0 in. wgSP is added. Best design is to have 7 to 10 duct diameters of straight ducting into the fan inlet.

Potential Electrical Energy Savings

The extra-accumulated SP losses from poor design on a small ft^3/min system can add approximately 4.1 in. SP.

Specifically, if a small weld fume collection system has a system static pressure (SSP) of 9.0 in. wg, poor design can add an additional 4.07 in. SSP for a total of 13.07 in. wg. Assuming 2400 ft^3/min, the brake horsepower (BHP) requirement for the 9.0-in. wg system would be 5.40. At 13.07 in. SSP, 7.84 BHP would be required.

Assuming the use of motors having the same efficiency, operating 8760 hours per year, and electrical costs of $0.11 per kilowatt-hour, the annual operating cost of the larger 7.84 BHP motor would be $5881. In comparison, the annual operating cost for the smaller 5.40 BHP motor in a simple weld fume dust control system would be $4003 for an overall electrical energy cost savings of approximately $1800 per year. Note that the energy cost savings potential increases in direct proportion to the size and complexity of the weld fume dust collection system.

Consult an Expert

The annual amount of electrical energy cost savings to be gained will depend on individual weld fume dust collection situations and requirements. For this reason, it is recommended that an expert be consulted to evaluate dust collection system requirements and the design approaches that will make the most economic and energy savings sense.◆