White Paper

Four Dust Collection System Design Improvements That Can Yield Significant Annual Energy Cost Savings

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Using good practice and correct design rules can have a substantial cost savings for the life of the dust collection system. The design and location of a systems hood, duct, and collector can collectively add sufficient static pressure requirements to the system that would then demand a larger, more expensive to operate motor necessary to maintain proper flow. Optimizing these areas can make it possible to use smaller, more energy efficient motors on the fan. The electrical savings for a simple dust control system can be more than $2,000 per year and significantly more on larger systems.

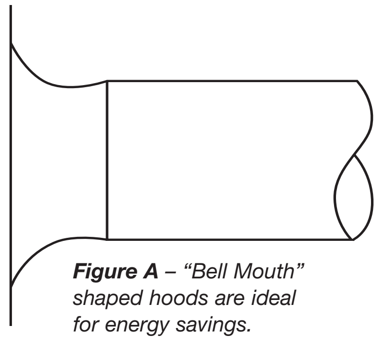

***Figure A** – "Bell Mouth" shaped hoods are ideal for energy savings.*

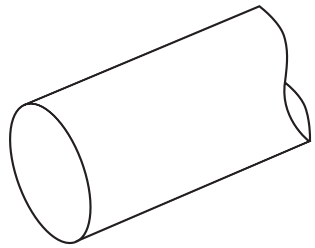

***Figure B** – Plain, or raw edge collection orifice.*

System Design Improvement Areas

Hood Design

"Bell Mouth" hoods (Figure A) have a low entry loss coefficient of 0.04 and are ideal for energy savings. In comparison, a plain or "raw edge" hood (Figure B) has an entry loss coefficient of 0.93. (Static pressure loss for a hood (SPh)= Loss Coefficient (Fh) x Velocity Pressure of the Duct (VPd) + 1.0 x VPd)). For example, if we use 4000 Ft/Min duct velocity the VPd=1.0. using the Hood Static Pressure Formula, SPh=0.04 x 1.0 + 1.0 x 1.0 = 1.04"wg for the Bell Mouth and 1.93" for the raw edge. This is an increase of 0.89"wg just for the hood.

Hood Location

The hood should be located as close to the source as possible. If the hood is 12" away vs 24" away, the volume of air required is reduced by the square of the distance. For example, if you were to locate a hood 12" away, you would need 1000 CFM. For the same application and same capture velocity locating the hood 24" away requires 4,000 CFM.

Duct Design

The air velocity required to transport dust is important to keep in consideration. If the dust can be conveyed at 3,500 ft/min (VPd=0.76), it would be a poor design to convey the dust at 4,500 ft/min where the VPd=1.26. To calculate the loss 100 feet of duct, you would use the formula, Fd x Duct Length (ft) x VPd. At 3,500 ft/min, your SP for loss = 0.018 x 100 ft x 0.76 = 1.37"wg. For 4,500 Ft/min, the SP Loss = 0.02 x 100 x 1.26 = 2.52" wg. Transporting the dust at the higher velocity of 4500 ft/min vs the required velocity of 3,500 ft/min increases the SP loss by 1.15" wg.

Well-designed branch entries will also effect the SP loss. Using a 30º entry has an entry loss factor (Fe) of 0.18. Using a 45º branch entry has a factor (Fe) of 0.28. As the angle of the entry branch increases, the loss factor increases causing even more SP loss. This loss is calculated by the VPd x Fe. Using 4,000 ft/min, the VPd=1.0. At 4,000 ft/min on a 45º entry is 1.0 x 0.28 = 0.28" wg. The loss for a 30º entry is 1.0 x 0.18 = 0.18"wg. For every branch entry at 45º vs 30º, you add an additional 0.10"wg SP. This loss can add up in even a small system.

Duct elbows also need consideration. The larger Radius/Diameter (R/D) ratio that is used, the lower the loss. We recommend using a R/D of 2.0. An R/D of 1.5 has a factor of 0.24. An R/D ratio of 2.0 has a factor of 0.19. Just this change will increase the SP loss of the elbow by 0.05" wg for every elbow.

Fan inlet ducting is another cost savings opportunity. A poor design is to install a two diameter 90 degree elbow right at the inlet of the fan. This serves to add 1.0" VP with the inlet at 4,000 ft/min. Should the design be such that there is 7-10 duct diameters of straight duct prior to the inlet, there is no loss. Thus another 1" of SP is saved.

The total savings after adding up the SP gained from a well-designed system is 1.15"+0.10"+0.05"+1.0" for a total SP savings of 2.30" wg.

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Dust Collector Operation
The operating controls of the dust collector can also provide a cost savings. A standard pulse jet collector comes with a Magnehelic® style gauge and the collector pulses at a set time interval regardless of the pressure drop across the filters. Upgrading to a Photohelic® style gauge to control the pulse jet not only saves compressed air and its associated energy costs, it also extends the filter media life. You can control the set point in which the filters are nominally dirty. You can set the gauge at 4”wg vs 5”wg for a 1”wg SP savings. The unit will also not pulse until a “dust cake” is formed on the filter which increases the filter efficiency.

A Variable Frequency Drive (VFD) with Auto Flow will also save energy costs. Rarely is a motor/fan selected to run at exactly 5HP or 10HP. If a fans BHP at the selected CFM is 5.43, a 7-1/2 HP motor will be required. Same with a selection of a fan at 7.65 will require a 10 HP motor. By adding a VFD and Auto Flow, the motor will only draw the amperes required to maintain the air flow. This is done by having a pressure transmitter send a signal to the drive and then the drive controls the air flow using a static pressure set point in the drive. This maintains your transport velocity regardless of the filter status. Using the 7-1/2 HP for example can save in excess of $967 per year. The 10 HP on a VFD will save approximately $1,290. This is based on running 24/7/365 (8760 hrs/year @ $0.11/Kw-hr).

Total Potential Savings
The extra accumulated SP losses from a poorly designed duct in this small system can add 4.19” SP (0.89” hood + 2.30” duct + 1.0” collector = 4.19”).

If this small dust collection system had a good design at 9.0”, the poor design would then be at 13.19”. Let’s also assume that the fan selection BHP is 5.43 for the 9.0” system and 7.65 BHP for the 13.19” system.

Assuming that the motors are the same efficiency, operating 24/7/365 and the cost for the electric is $0.11/Kw-Hr, the cost difference in operating the motors is just under $2,000 per year. Then add on the savings for the VFD, your savings then it increases to almost $3,000 per year. This does not include the cost savings from the Photohelic® (compressed air). The annual amount of electrical cost savings to be gained will depend on the individual dust collection situation and requirement. For this reason, it is recommended that an expert be consulted to evaluate dust collection system requirements and the design approach.

Have Questions?
The application engineering team from Parker Hannifin | UAS has significant experience to assist you in selection of your dust collection system. We can assist you in the design to reduce your electrical usage and eliminate costs in the system design. Questions can be directed to filtration@parker.com.

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