CALCULATING CLEAN AIR

A Total Cost of Ownership analysis helps welding shops determine the best dust collection system

by Jon Ladwig, welding systems market manager, and Matt Caulfield, director of OEM sales, Camfil Air Pollution Control

In welding operations, a well-designed and maintained dust and fume collection system works to prevent respiratory problems in employees and keep facilities in compliance with current air quality requirements. Threats that need to be contained include metal dust particles and welding fumes, which can contain iron, lead oxide, nickel, zinc oxide, hexavalent chromium and manganese (the primary metal in welding wire).

Therefore, proper dust and fume collection is imperative when following OSHA exposure guidelines for these risks. In some cases, a good dust collection and ventilation system can eliminate the need for personal respirators and the challenges of getting employees to wear them. In addition, proper dust collection can protect the costly, sensitive equipment often used in fabricating plants. Equipment like cranes, robots, welders, automation and other computerized systems must be protected from exposure to dust and welding fumes.

MAXIMIZING INVESTMENTS

Whether you are considering the purchase of a new dust collection system or simply assessing which replacement filters to use in an existing dust collector, conducting a Total Cost of Ownership (TCO) analysis can ensure that you get the best results as economically as possible. A TCO analysis can compare the real costs of operating a dust collector with different filters as well as evaluate the impact of energy-saving electrical components in the design of new and refurbished dust collection systems.

A TCO analysis looks at four key operations factors: energy, consumables, maintenance and disposal.

When calculating TCO, a primary consideration is the amount of energy required to operate the dust collector from day to day, including electrical costs, compressed air usage and CO_2 emissions. The largest portion of the electrical load is used by the fan or blower required to move air through the system. Differential pressure losses are directly proportional to the ▸

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Open-pleat style cartridge filter media.

Open-pleat style replacement filter cartridges.

amount of air moved through the system, which, in turn, is directly proportional to the cost of electrical energy used by the fan.

Another major factor in saving energy is to determine if you can recirculate the filtered air back into the facility. This saves energy by not having to bring in and condition (heat or cool) make-up air from outside, and it also helps to keep a facility pressure balanced.

Of the consumable components of a dust collector, the priciest ones to replace are cartridge filters. Maintenance and disposal includes the time it takes to service the equipment and the costs of disposing the consumables. This includes the amount of money required to have replacement filters delivered to the operation site and the amount of money required to carry inventory of replacement filters.

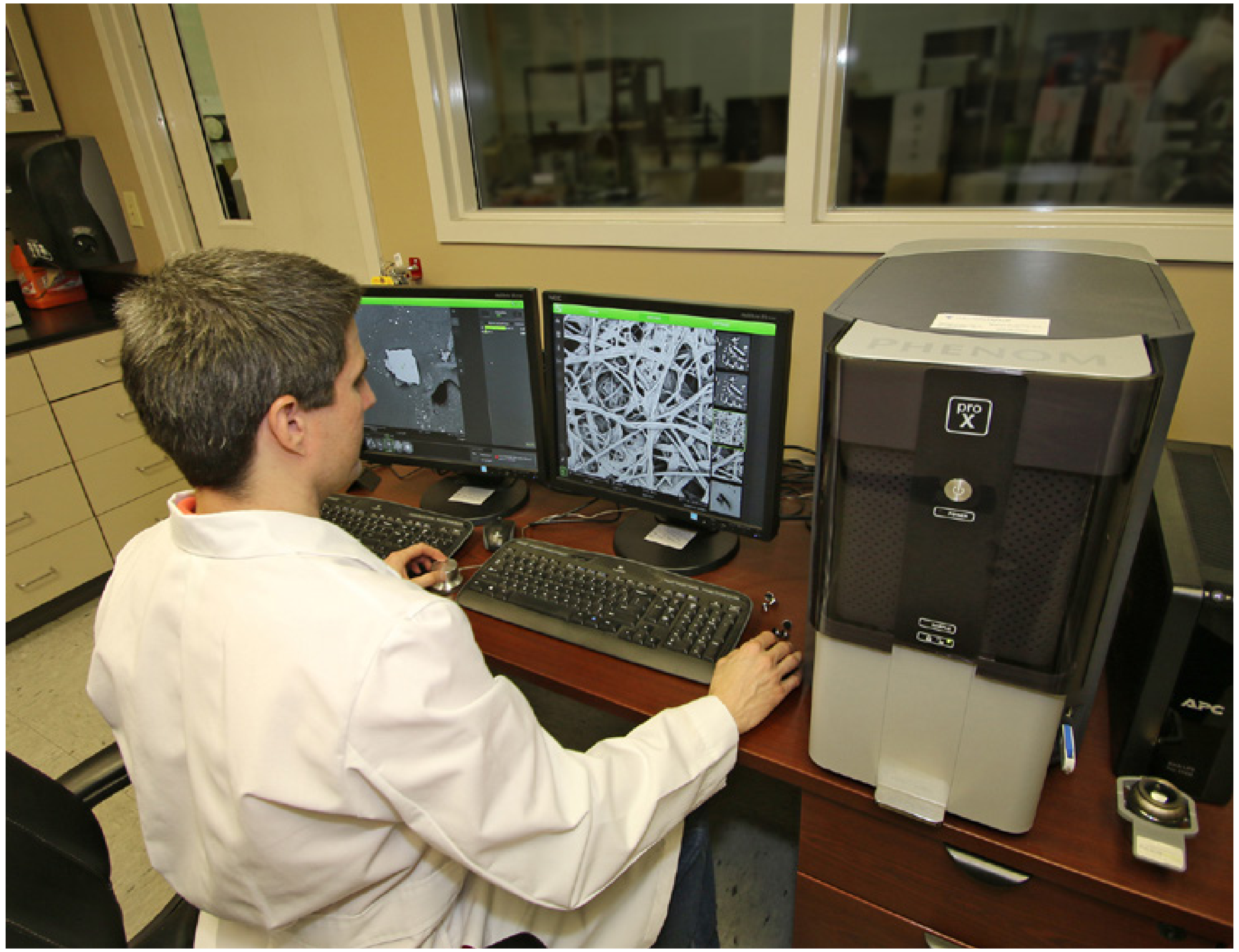
You must also factor in the cost of labor required for maintenance personnel to change filters.

Depending on the type of material being filtered, there is also a cost associated with properly disposing of filters laden with process dust, especially if it is hazardous. And don't forget downtime costs due to stopping operation of the dust collector for a filter change.

FOCUS ON THE FILTERS

Operational factors are largely dependent on the anticipated service life of the filters. A filter changeout schedule will determine how many filters you can expect to buy, transport, store and dispose. It will also give you a solid idea as to the costs of labor and downtime associated with filter replacement.

Interestingly, filters use more energy in the early stages of service life and less in the final stages. When filters are clean and differential pressure is at its lowest, more air blows through the system than required, which wastes energy. As filters become loaded with dust, static pressure is increased and less air is moved as a result.


Dust analysis creates the basis for evaluating Total Cost of Ownership.

One way to reduce this problem is to use a variable frequency drive (VFD) that electrically controls fan speed. When filters are new, speed is decreased to obtain the desired airflow. When filters become loaded, the fan is sped up to maintain a constant airflow. The electrical control is highly efficient in maintaining desired airflow, and energy consumption is greatly decreased.

In fact, the use of a VFD has been proven to save an average of 4 in. WG of static pressure over the life of the filter. The added capital cost of installing a VFD on a dust collector varies. However, you'll likely see return on investment in under one year.

DUST TESTING

Clearly, TCO is greatly influenced by choosing the best filters for your application. Dust testing data creates the building blocks for evaluating the TCO. Make sure the filters you are considering for purchase have the necessary filtration capability to meet regulatory permissible exposure limits for your operation and type of pollutants. Other important factors to note when determining the best filter choice are the size and shape of the dust particles to be collected, whether the dust is combustible and if it is dry or sticky.

Having dust samples professionally tested helps you understand the characteristics of the material you are dealing with, so you can make informed decisions on equipment, filter cartridges and engineered controls to mitigate dust hazards. Dust testing services to consider, based on your specific operation, include:

- Particle size analysis: These tests determine the filtration efficiency required to meet emissions standards.
- Video microscope: Knowing dust shape and characteristics is vital to selecting proper equipment.
- Pycnometer: Knowing the dust's true specific gravity helps determine the efficiency of cyclonic-type dust collectors.
- Moisture analysis: Identifying moisture-absorbent dust is essential in selecting effective filters.
- Abrasion testing: Knowing the dust's relative abrasiveness helps determine the optimal design of dust handling components, such as valves, inlets and ductwork.
- Terminal velocity testing: Knowing what air velocity is required to lift the dust helps determine the correct filter housing size.

It's also recommended to test your dust collector for ASHRAE/ANSI Standard 199, which requires specific dust types to be fed into a collector at a specified rate and to a specified

It's essential that equipment such as robotic welders be protected from exposure to dust and welding fumes.

differential pressure. From there, the standard requires the dust to proceed through pulse cleaning, several cycles of dust loading and a simulated upset condition to generate performance data.

CHARTING THE DATA

To make an informed decision about your dust collection filter purchase, worksheets are available to help you chart your data. Figure 1 is a sample dust collection worksheet used to gather TCO data and lists two different filters, both containing standard media with standard cartridge filtration efficiency.

Lines 6 and 7 of Figure 1 note the cost of Filter A and Filter B, respectively. And, lines 14 and 15 note the time it takes to change Filters A and B, respectively.

In this example, Filter A, at a unit cost of $90, is a conventional dimple-pleat

Dust Collector Filter Total Cost of Ownership - Sample Data Collection Worksheet	
How many days will the system operate per year?	365 days
How many hours will the system operate per day?	24 hours
What is the volume of air required to operate the system?	10,400 cfm
How much does a kilowatt-hour cost?	$0.10 per kWh
What is the cost of no production for one hour?	$500
What is the cost of Filter A (conventional-pleat filter)?	$90
What is the cost of Filter B (open-pleat filter)?	$120
How many filter cartridges are in the dust collector?	16
What is the shipping cost per filter?	$10
What is the labor and overhead rate for one hour?	$80
How much does it cost to dispose of a filter?	$10
How much does a variable frequency drive (VFD) cost?	$2600
What is the current interest rate?	4.5%
How many minutes does it take to change Filter A?	10 minutes
How many minutes does it take to change Filter B?	5 minutes
Will there be a VFD operating the system?	Yes

Figure 1. Sample data collection worksheet.

Figure 2. Savings using a 16-cartridge dust collection system equipped with an open-pleat-style cartridge filter.

Electrical Savings	
Using standard efficiency motor	$2,472.22
Using premium efficiency motor	$2,935.76
Using premium efficiency motor with VFD	$11,743.06
Return on investment for VFD	2,586 hours
Compressed air savings	$195.97
CO_2 emissions savings to environment	50.27 tons
Total energy savings (with VFD controller):	$11,939.03
Consumable Savings	
Cartridge only replacement savings (50% longer life)	$505.38
Transportation savings	$168.46
Inventory savings	$90.97
Total consumable savings:	$764.82
Maintenance and Disposal Savings	
Labor savings	$786.15
Disposal savings	$168.46
Downtime savings	$758.08
Total maintenance and disposal savings:	$1,712.69
TOTAL COST OF OWNERSHIP (TCO) SAVINGS:	$14,416.54

style cartridge filter. Filter B, at a unit cost of $120, is an open-pleat style cartridge filter designed for extended service life and lower pressure drop operation.

Another worksheet is shown in Figure 2 that considers the four key operational factors and uses data from the first worksheet shown in Figure 1 to project the TCO of a new 16-cartridge dust collection system equipped with Filter B. Though it has a higher initial cost than Filter A, Filter B operates at a lower pressure drop over a longer period of time to save on energy use.

In some cases, a good dust collection and ventilation system can eliminate the need for personal respirators and the challenges of getting employees to wear them.

Furthermore, Figure 2 shows savings achieved by combining Filter B with energy-efficient electrical components. The use of a premium efficiency motor alone yields savings over a standard efficiency motor, but the best savings by far are realized with the combination of a VFD and premium efficiency motor – nearly $12,000 in projected savings over 8,760 operating hours or one year.

When you add it all up, dust collectors that are designed based on facts rather than guesswork perform as required with lower energy and operating expenses. To make the most cost-efficient choices for your dust collection system, work with your equipment supplier to help you gather the data you need. And, by charting TCO for various filter types, you'll be able to compare the real costs of operating a new or existing dust collector and make the best choice to keep your workers safe and your welding operation in compliance. ■