

# PNEUMATIC POINTS TO PONDER

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## Improving overall cost-effectiveness of your pneumatic conveying system and dust collection system

**P**neumatic conveying systems and nuisance dust collection systems have more in common than just filtration equipment. Both unit operations can readily become problems for a plant when sufficient planning or investment doesn't take place at the beginning stages of plant construction or when cost becomes the controlling factor. The issues may be related to an individual piece of equipment, such as a dust collector, or to the system as a whole. For that reason, we invited David Renfert, an expert in dust collection systems, to co-author this article, sharing his experience with issues in dust collection systems and equipment since many manufacturing facilities typically implement both unit operations as part of their process.

### Plan for the future

Adages, such as "measure twice; cut once" or "pay me now or pay me later," seem to apply universally to just about any situation in life, either directly or as a variation on a theme. In terms of industrial processing applications, pneumatic conveying systems and dust collection systems are no exception.

All too often, systems are put together without much thought or planning or with cost being the driving consideration. This can lead to a range of issues including insufficient

system performance, excess energy use, product damage, equipment damage, operational downtime, or limited flexibility for changes to the process or associated system. Although this article discusses variations on these themes as they relate to designing, specifying, or purchasing pneumatic conveying systems and dust collection systems, the ideas certainly can be applied to other industrial unit operations or systems.

### Consider the process as a whole

Pneumatic conveying systems and dust collection systems often are configured, quoted, or installed without considering all aspects of the situation, the range of potential processing operations, or alternative design options. Such oversight often leads to problems that end up costing the end user much more than just the system's capital costs. Many times, we find the end user sacrificing production capacity or experiencing high reject rates as the result of inadequate solids handling equipment performance.

#### *Pneumatic conveying systems.*

When designing or specifying a pneumatic conveying system, remembering that the goal of such a system is more than just transferring material from point A to point B is important. Proper system design

seeks to avoid damage to the conveyed material (attrition, degradation), damage to the system components or equipment (abrasive wear), excess energy usage, and overtasking the filtration media — among other issues — all while providing reliable system operation and material transfer at the necessary rates.

For example, consider a hypothetical situation where a system can convey a given material at the required rate in either a 3-inch or 4-inch line, starting with a target pickup velocity. Because both the clean-air line loss-per-foot at a given velocity and the material-to-air ratio increase as the line's diameter decreases, conveying in a smaller line size with a given pickup velocity requires a higher system pressure. This pressure results in a higher velocity at the system's end for a constant line size, which can cause several issues. For some situations, systems that were intentionally configured to transfer materials in dense-phase or two-phase flow at the start of the system will likely convert to complete dilute-phase transfer toward the end of the system.

Of course, choosing a larger line size will increase the size of the system's components, but this higher capital cost upfront is often offset by the cost avoidance associated with issues caused by high system velocity. Remember that the previ-

ously mentioned issues of material degradation and abrasive wear have been correlated with gas velocity raised to a power between 3 and 4.

**Dust collection systems.** For dust collection systems, design activities are often limited to performing a “quick and dirty” analysis or applying rules of thumb that may have worked in a prior application but aren’t applicable to the situation at hand. As a result, reduced system performance, including poor dust capture or a compromised allowable differential pressure level, can occur.

For example, when sizing a fan, the actual cubic feet per minute of airflow to be delivered by the fan at a calculated resistance is based on the fan’s inlet conditions. At a minimum, the combined flowrate for the pickup points or connection points will be lower than the total rate at the fan inlet due to the change in gas stream density. For lower-static-pressure systems, the change may not be significant. However, if temperature changes occur at points in the system, the combined effects can significantly change the fan and system requirements.

If a fan is configured using incorrect airflow or static pressure levels, the system may not provide the total system flow to achieve proper capture at the dust-generation points or may reduce the allowable differential pressure across the media to achieve the desired flow.

A common problem in many situations is that design or configuration practices that are less-than-optimal become standard and a part of the company’s transferred-knowledge base. These “norms” that worked — or were made to work — in one situation are then applied universally without a thorough vetting of why the solution worked in that situation. The common phrase “we’ve always done it that way” becomes a go-to justification for performance issues.

Thoroughly investigating these practices and making informed decisions at the front end of a project or a system selection process, considering the system as a whole,

will shift the likelihood of success from the ought-to-work column into the will-work column.

### **Pay me now or pay me later**

Another common issue that often leads to performance problems is allowing cost to become the most important factor in designing, specifying, or configuring pneumatic conveying systems and dust collection systems.

Cost-cutting measures, or a “close-enough” mentality, can lead to long-term issues that end up eliminating any cost savings initially associated with a less-than-optimum design or configuration. These measures may be related to the choice of technologies for a process requirement or the component selection.

Installing marginally sized systems or components that continually operate at near-maximum performance levels inherently put a system’s performance in jeopardy. Small changes that often occur during that system’s installation then can shift the performance outcome.

**Pneumatic conveying systems.** For example, configuring a pneumatic conveying system to run near the maximum capability levels of its components provides little flexibility for allowing required installation changes — extra elbows for example — or room for future production needs.

Equipment vendors may be willing to provide marginally sized systems or components to be the lowest-cost supplier in a group. The equipment offerings likely will meet the capacity requirements for that specific project; however, when considering the installation costs across the life of a project, those upfront cost savings end up being overrun by the operational costs associated with having to remedy poor performance or needing to purchase a higher number of replacement parts or dealing with the lack of flexibility to meet incremental system demands.

**Dust collection systems.** With dust collection systems, configuring a collector to run near the highest allowable air-to-cloth ratio or inter-

stitial velocity level often leads to risky system operations. Overtasked filtration media must be cleaned more often and with greater pressure to maintain the differential pressure within allowable levels. Excessive cleaning activities can lead to reduced bag life and the likelihood of particulate emissions. Such issues could be avoided by something as simple as providing one more row of bags or — in some cases — longer filter elements to increase the effective filtration surface area in the initial system design.

Additionally, vendors may seek to lower their internal (and quoted) costs by installing marginally sized components for the system’s cleaning system. For example, compressed-air manifolds of a certain diameter or larger require a stamp indicating compliance with ASME standards for unfired pressure vessels. This requires purchasing the manifold from an approved shop, which increases the cost. To avoid this, an equipment supplier may go with a smaller manifold selection, which reduces the cleaning system’s effectiveness. Undersized or insufficient cleaning systems can lead to a wide range of issues, including reduced bag life and higher residual differential pressure.

Another cost-cutting measure relates to flow control. For dust collection systems, proper system flow control is essential to maintaining process stability, optimizing collection performance at the source, minimizing equipment and component damage, minimizing material degradation, maximizing filtration equipment performance, and limiting energy usage to an appropriate level.

Proper system flow control is more than just providing a fan-control device, it involves providing an appropriate device and using the correct reference signal when adjusting that device. A system that’s allowed to run wide open or is controlled improperly will usually play host to a wide range of problems, including performance issues with the dust collection function.

Additionally, for multiple-segment

duct networks, a means of balancing the segments and maintaining that balance is crucial to the system's successful operation. Unbalanced systems lead to excess dust entrainment at some sources and insufficient collection at other sources. In order to achieve the minimum required flow at all points, the total flowrate for an unbalanced system must be higher than design levels. Unfortunately, system imbalance often goes unnoticed; the fact that total system flow is higher than design is overshadowed by the fact that there are exhaust points with insufficient capture.

When a system is not balanced and not controlled properly, the total system flow is often much higher than design. In one instance, a customer called in numerous times to report that a new system wasn't capturing dust at all of the exhaust points and that the differential pressure across the media was much higher than anticipated based on comments made at the time quotes were made. Amperage readings on the fan indicated the total flow was higher than design level, leading to confusion.

An appropriate system analysis determined that the system wasn't in balance, leading to insufficient dust capture at some points even though the total system flow was higher than design.

The analysis also discovered that the fan had been sized using a rule-of-thumb for the required static pressure rather than a value determined by a practical system design process. As a result, the allowable differential pressure across the media was significantly reduced below design level in order to try reaching the design flow level.

To provide the required system flow and achieve a reasonable allowable level of differential pressure, the fan's static pressure output had to be increased. Typically, this static pressure output change can be achieved with a fan speed change, but as part of the installation's cost-control measures, a direct-drive fan had been used instead of a belt-driven fan. Remedying the situation quickly

became expensive because the fix required a variable frequency drive to allow for the fan speed change, and a new inverter-duty motor had to be purchased for the fan.

After the changes were implemented, the system was operating as intended but the company's reputation had already been damaged. Sadly, all of these issues could have been avoided if appropriate design practices had taken place and the company had selected more practical equipment.

Sometimes, the project cost increase to provide appropriate components is inconsequential when considering the benefits that the investment provides. Clean-on-demand components for controlling the cleaning cycle on a dust collector is a prime example. Since many dust collector control boards are configured to require a choice between continuous cleaning based on time and on-demand cleaning based on differential pressure levels, the cost difference often relates only to the differential pressure measurement device (switch versus basic gauge).

### **Your next proposal**

The next time you're reviewing new equipment proposals, take a few moments and place a sharper focus on individual components and their respective performance — both as part of the entire system and considering their own maximum-rated levels. By changing out some of those individual components to the next larger size or incorporating some of the suggestions made in this article, you can not only strengthen a component's performance level, you can also raise the quality of the overall system design. **PBE**

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### **For further reading**

Find more information on this topic in articles listed under "Pneumatic conveying" in *Powder and Bulk Engineering's* article index in the December 2017 issue or the Article Archive at *PBE's* website, [www.powderbulk.com](http://www.powderbulk.com). (All articles listed in the archive are available for free download to registered users.)

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