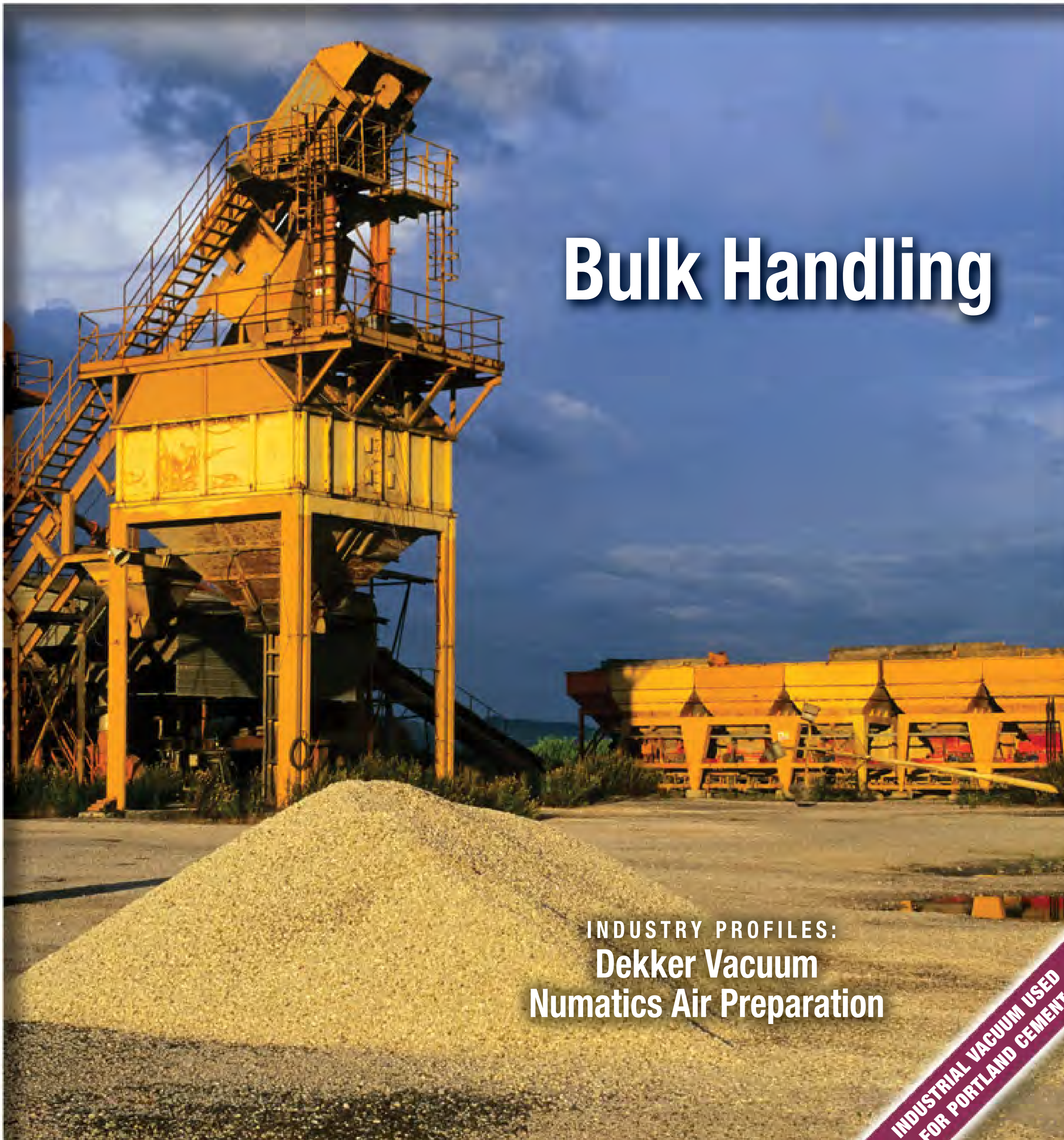
Auditing Dense-Phase Transport | **Material Conveying with Pneumatics**

February 2008

COMPRESSED AIR BEST PRACTICES



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* Reference: *Best Practices for Compressed Air Systems,* Compressed Air Challenge, 2nd Edition, 2007.

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FROM THE EDITOR

The Vacuum and Blower Challenge

Greatness usually comes during times of great challenge or duress. Few have the discipline to achieve greatness when things are "ok." Sports greatness often is realized when there is a demanding coach. Business greatness often requires a tough leader. Academic achievement sometimes requires a few of the famous "all-nighters."

U.S. industry has responded to the challenge of 2001 when many thought the "off-shoring" of manufacturing would never stop. Productivity indexes show that U.S. industrial efficiency has gone through the roof since then. Costs have been taken out of industrial operations while output has gone up — while maintaining or improving quality. U.S. manufacturing has stabilized and its' future is bright (in my humble opinion).

Compressed air systems have been heavily audited this decade and countless firms have stopped wasting the $100,000 to $1 million per year they had been throwing down the drain for years. The fight to keep the factory doors open made utility engineers and plant managers challenge everything to promote efficiencies. They challenged many historic notions with compressed air systems (like it's free) to capture the savings.

While much is yet to be done with "100 psig" compressed air, a growing opportunity exists with vacuum, blower and pneumatic systems in industry. Several auditor friends of mine, who have recently completed big audits of these types of systems, tell me that the inefficient vacuum, blower and pneumatic systems remind them of "100 psig" compressed air systems ten to fifteen years ago.

For this reason, Compressed Air Best Practices Magazine is challenging itself to expand the scope to include "Best Practices" in vacuum, blower and pneumatic systems. This month's Focus Industry of "Bulk Handling" provides us with the perfect opportunity to look at vacuum and blowers. The challenging environments of cement plants, for example, require a sophisticated mix of vacuum, low-pressure blowers, and "100-psig" compressed air. Our thanks go to auditors Brent Ehrlich, Hank Van Ormer and Dan Bott, for sharing their experiences in these areas with us this month.

Finally, does your company allow employees to have enough self-confidence to challenge themselves and ask themselves (or their manager), "What can I do better"? Does your firm encourage employees to push themselves out of their comfort zone? Or does the company culture reward employees who are very effective at documenting what they do well — or worse, does your firm reward and promote employees who are marvelous at documenting things that others do? We have included an article on this topic, by Don Schmincke, which we hope provokes some thought.

ROD SMITH

UTILITY-AIR NEWS

Ingersoll Rand Continues Acquisitions

Ingersoll Rand announced, in September 2007, that it was acquiring OMI a privately held Italian air dryer manufacturer. This acquisition provides IR with a European manufacturing center for compressed air treatment products. On December 17, 2007, IR announced the acquisition of Trane Inc., for approximately $10.1 billion. The combination of the two firms creates a new global, diversified industrial company with projected 2008 revenues of $17 billion. Ingersoll Rand's 2007 annual revenue projections are estimated to be $8.7 billion. The acquisition is described as a significant step in transforming Ingersoll Rand into a global market leader in the climate control, industrial and security markets.

CAGI Introduces "SmartSite" — Online Learning and Info Center

The Compressed Air and Gas Institute (CAGI) has introduced an online learning center for compressed air. A key feature of SmartSite is its E-Learning courseware. Titled "Introduction to Compressed Air Systems," this courseware offers users industry-standard training, available 24/7, that is manufacturer and product neutral. It allows participants to learn at their own pace, in the comfort of their homes or offices, and eliminates the need to travel or spend hours at a time in the classroom.

With continued access to the courseware for a year, students can plan refresher sessions or resolve even the most complex questions, and they can use the courses as Continued Education Units, where CEUs are needed. In addition to the E-Learning courseware, the SmartSite will, over time, incorporate most of CAGI's information resources, such as technical papers, videos, CDs and placement of orders for its widely used handbook. CAGI's SmartSite can be reached by clicking on the SmartSite logo at http://www.cagi.org/home.asp

The Compressed Air Challenge® Releases New "Best Practices" Manual

The Compressed Air Challenge® (CAC) recently released a new and improved second edition of the highly regarded "Best Practices for Compressed Air Systems" manual. This new version maintains the informative "how to" quality of the first manual by providing an abundance of data for use to help compressed air end users and service providers to improve operating efficiencies and reliability of compressed air systems. However, readers will now benefit from expanded sections and appendices in this newly released version. Highlights of this new version include:

- New information on variable speed drive compressors, two-stage and single-stage rotary screw compressors
- An expanded and updated section on various control strategies for installations involving multiple compressors, including proper application of variable speed drive machines in a variety of configurations
- The latest information on ISO compressed air quality standards and the selection of filters and dryers to meet the requirements of many applications
- CAC Basic System Assessment and Comprehensive Audit guides
- Updated references to relevant standards Compressed Air and Gas Institute performance data sheets and verification labels

KNOW PRESSURE
COMPRESSED AIR CHALLENGE™

By providing readers with the information they need to implement recommendations, one can strive to achieve peak performance and reliability of the system at the lowest operating cost. The CAC believes that through implementing the approaches presented in the manual, you will:

- Reduce energy and repair costs
- Improve system reliability
- Increase productivity
- Reduce unscheduled downtime

The manual begins with the considerations for analyzing existing systems or designing new ones, and continues through the compressor supply to the auxiliary equipment and distribution system to the end uses. The reader can determine how to use measurements to audit and manage his own system, calculate the cost of compressed air and even learn how to interpret utility electric bills. Best practice recommendations for selection, installation, maintenance and operation of all the equipment and components within the compressed air system are in bold font and are easily selected from each section.

The CAC was formed in 1997 as a voluntary organization to promote greater energy efficiency in U.S. industrial compressed air systems, with a specific focus on education. You can obtain the CAC's "Best Practices for Compressed Air Systems" manual at www.compressedairchallenge.org. BP

Compressed Air Audit of the Month

Dense-Phase Transport Wreaks Havoc on Compressed Air System

By Brent Ehrlich

February Audit of the Month

Where: **Georgia**

Industry: **Ceramics Processing**

Issue: **Periods with Insufficient Air Pressure**

Audit Type: **Supply-Side Compressed Air Storage**

Question: **Buy a new air compressor or install storage capacity?**

Scenario #1: Buy a New Air Compressor:

Capital Costs:	**$ 50,000**
Power & Maintenance Cost Increase*:	**$40,600**
1-Year Cost Increase:	**$90,600**
5-Year Cost Increase:	**$253,000**

Scenario #2: Install Storage Capacity & Modify Controls

Capital Costs:	**$123,000**
Power & Maintenance Cost Decrease*:	**$81,200**
1-Year Cost Increase:	**$41,800**
5-Year Cost Decrease:	**$283,000**

Conclusion: Installing Storage Capacity and Modifying Compressor Controls will solve the insufficient pressure issue while saving the company $536,000 (over 5 years) versus purchasing a new air compressor.

*Annual increase/decrease at 50% load

The Problem

Sitting on his desk the day Brian began his new job as Plant Engineer for a ceramics processing facility was a proposal to purchase a new 150 HP air compressor as a backup machine. The facility already had six of these machines and, yes, all six ran almost continuously. A rental unit was already on site and "installed" as a backup, just in case a permanent machine failed. The new compressor was intended to replace that rental. Brian had worked with me (Brent Ehrlich) together on a couple of projects in the past and had learned enough from those projects to recognize that nowhere did the proposal state that the existing compressors were being used efficiently. Nor did the proposal identify the problem a new compressor would solve. There was only a mention of the symptoms: all installed compressors ran continuously, and pressure was unstable, fluctuating as much as 25 psi. The source of these symptoms was not evident. It might be on the demand side, in the compressor controls, or reflect a real lack of capacity. Brian suspected that if the underlying problem was understood, the existing compressors could be used more efficiently, allowing one of them to be turned off and used as the backup compressor.

To identify the problem, we needed more data. We needed a thorough understanding of how compressed air was being applied. The data presented to support the purchase of a new compressor showed the amperes used by each compressor, with a separate trend for each. This showed that all compressors remained on-line continuously (or nearly so), but it also revealed that multiple compressors were simultaneously running at part load, an indication of inefficient operation. My guess was that production events creating significant peaks in demand were causing all six compressors to load. When the events ended, some would unload and run unloaded until the next event occurred. But nothing was known about these peaks, or even if they existed at all. How much air (volume) was involved? What did the flow profile (rate and magnitude of change) look like? What was the maximum flow rate? How long did the events last? What were the actual pressure requirements? My goal was to provide Brian with a clear picture of production's needs so that he could make an informed decision.

Compressors make flow. Production demands flow. So if we want to match compressor horsepower (supply) with the demand, shouldn't we measure flow? As we all know, we can't manage what we don't measure, so we jolly well had better measure something! Having received the same training in flow measurement that NASA engineers get, I tend to favor measuring this parameter, however, similar information can be obtained from data for kW, amps or pressure. AirMaster+ software, available from the D.O.E., will even correlate flow to load/unload cycle times.

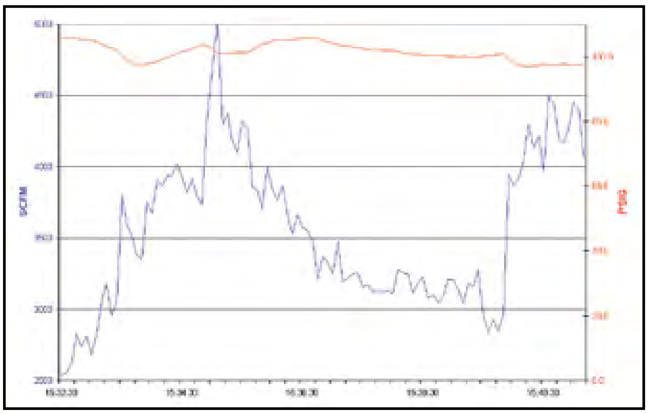
The Audit Proposed a Compressed Air Storage Solution to Ensure Adequate Air Pressure

On the Demand-Side

To get the needed information, I used a flow meter and a pressure transmitter. I hot-tapped the 8" main where it entered the plant and installed an insertion-type thermal mass flow meter. I fed the output of the flow meter and the pressure transmitter through a PLC, then into a laptop using System Control And Data Acquisition (SCADA) software to display and record the data. This setup allows real-time, high-resolution display and will record gigabytes of data. I later transferred the data to a spreadsheet for analysis. (An averaging pitot tube and the associated transmitters were later installed permanently.)

Changes in the flow rate frequently exceeding the capacity of two compressors occurred in seconds — in this case, an increase of 1,300 scfm in 15 seconds, **a doubling in less than three minutes**. It became obvious that we needed to examine the demand side and correlate events in production with the observed changes in flow.

The data we began to see was a real eye-opener. Parts of the trend looked like this:



The data displayed in this chart is the output of a Thermal Mass meter. Interestingly, an Averaging Pitot Tube provided smaller values for the peaks. The TM meter is a single point instrument; it takes a reading at a single point near the center of the pipe and applies an algorithm to compensate for the velocity profile. However, when flow increases very rapidly the velocity profile is momentarily distorted with a relatively higher velocity down the center of the pipe. The algorithm (at least in my meter) does not seem to compensate properly for this distorted profile and outputs a value that is artificially high. The averaging instrument is not susceptible to this phenomenon.

COMPRESSED AIR AUDIT OF THE MONTH

Dense-Phase Transport Wreaks Havoc on Compressed Air System

Dense-Phase Transport Systems Create Demand Peaks

A number of dense-phase transport systems were in use. Comparing time stamps associated with the operation of these systems and the time stamps in my data, I was able to identify how much air was needed to cycle each of them, the frequency of their use and when they were being used simultaneously. This information would be useful later in helping to manage the demand, but for now, we had learned part of what had not been known: the peaks were significant (increasing as much as 2500+ scfm) and of short duration (60 to 90 seconds). Two compressors were running continuously to serve peaks lasting only 90 seconds. If these peaks in flow could be served from stored air, at least one compressor could be turned off. But would there be enough off-peak, surplus capacity to store from just five compressors? If so, how large would the receiver need to be and how much would pressure need to change? I collected more data; I wanted to be certain that I had recorded and could analyze the worst-case scenarios. We also needed to validate pressure requirements so we could deliver air at a pressure appropriate to needs of production. Our hope was to be able to lower pressure. Without data, all I had was another opinion, and I don't devise engineered solutions solely on opinion.

Now we had learned which production events created peaks in the flow rate that required all compressors to run, how large the peaks were, how long they lasted and how often they occurred. Because the individual events were brief, we suspected that they could be served from air stored in a tank. However, we also identified reoccurring two-hour periods when a continuous series of transport events were occurring. These periods established the highest average demand. We needed to be able to turn off a compressor during these periods.

Three Ways to Meet Intermittent Demands

There are three well known approaches to meeting large intermittent demands. These are:

1. Demand-side receiver(s) dedicated to the event.
2. Compressor(s) dedicated to the event.
3. A supply-side receiver.

In this instance there are a number of transport systems, some are located at the farthest corners of the plant, and one in the middle. Dedicated equipment for each of them wasn't a practical option.

On the Supply-Side

Our approach to the problem of serving large intermittent demands uses a computer application I developed called Flow Based Analysis (FBA) to compare the capacity of installed compressors (supply) with the recorded flow (demand) and to seek an equilibrium. We enter information on the supply, such as the maximum pressure capability, capacity in scfm at maximum full flow pressure (MFFP), kW at MFFP and unloaded kW, for each compressor. We also enter information on power cost. We then enter information on the demand — the actual system flow data, typically in 12-hour blocks where data was sampled at 5 second intervals. FBA will then model the behavior of the system as system parameters are manipulated.

Three Areas of Flexibility

First, we can manipulate the recorded value for flow. Maybe there are a few leaks or other forms of waste we can fix to suppress the demand, or we can increase the rate to reflect the addition of new production equipment. Second, we can manipulate the total receiver volume. Third, we can manipulate the pressure set points used for compressor control.

The algorithms in FBA compare the capacity of compressors (supply) to the recorded flow (demand) for every entry (every 5 seconds in this case). If there is a surplus, pressure rises. If there is a deficit, pressure decays. If pressure decays to the "load" set point, the application models the starting and loading of another compressor. If pressure rises to the "unload" set point, a compressor is unloaded and stopped after a timer runs out. We can increase receiver volume and change the span between control set points. This manipulates the volume of air stored. As the volume increases, the frequency of compressors loading and unloading decreases. Perhaps, we will get to a point where one compressor (or more) shuts down and does not restart. If total receiver volume is too small, pressure will decay below an acceptable point no matter how wide the control span, and additional horsepower will be needed. Total volume cannot be too great, but the cost of the tank could be prohibitively high. The computer is actually simulating what is going to happen in the compressor room as the flow rate, receiver volume and set points are changed.

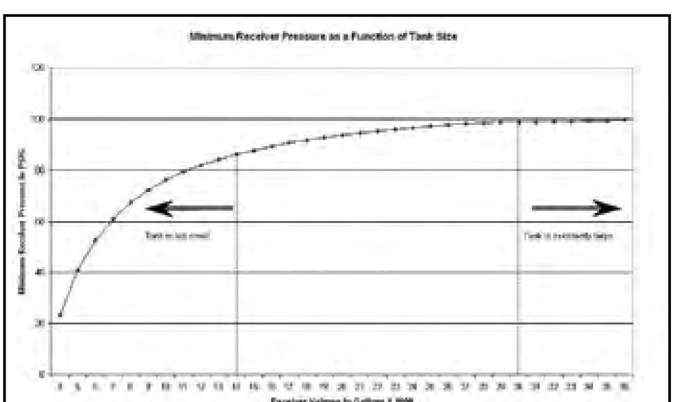
The chart to the right illustrates the storage options for the system in question. It shows the minimum pressure we would be able to maintain during the worst-case event as receiver volume changes and only five compressors are allowed to run. The model reveals that even with a span of 15 psi, if less than 14,000 gallons of receiver volume is added, the worst-case series of transport events will draw down the system, causing an uncontrollable decay of pressure.

However, FBA showed us that even after adding 14,000 gallons, a compressor would still unload. There was unrealized capacity from this compressor, and we would need a larger tank to make use of it. The math showed that we needed at least 27,000 gallons of additional volume (with a 15 PSID) to keep this compressor loaded through the entire worst-case series of events. With this much storage, we would be able to control pressure and idle the sixth compressor.

Yes, this 30,000-gallon air storage receiver is as big as it appears: 9' in diameter and 70' in length.

Power Cost

Flow Based Analysis (FBA) was also used to estimate the annual power cost for the system. We watch this estimate to see if the increased receiver cost is justified by power cost savings. There is also the question of how much of a change in pressure (ΔP) will be required. The volume of usable air stored in a tank is a function of both its size and the ΔP. Reducing the ΔP allows us to reduce system pressure and, therefore, power cost, but it increases the size and cost of the tank needed. Reducing pressure may also allow compressor drive motors to operate at or below nameplate Full Load Amps (FLA), not in their service factors. In this case, a combination of technical and budget considerations led us to purchase a used 30,000-gallon receiver.



Notice how minimum tank pressure increases with tank volume.

COMPRESSED AIR AUDIT OF THE MONTH

Dense-Phase Transport Wreaks Havoc on Compressed Air System

Flow Based Analysis (FBA)

FBA applies this formula for every row of data: $\Delta P = ((T)(C)(PSIA)) \div V$, and then updates pressure in supply side storage. If pressure reaches a set point, the flow from another compressor is either added or removed from the calculation for "C".

Where:

V = volume of the tank in cubic feet (for a 30,000 gallon tank: = 30,000/7.48 = 4,010.7 ft3)

ΔP = the change in pressure in the tank

PSIA = atmospheric pressure (14.5 PSIA)

T = Elapsed time in minutes (for 5 second intervals: = 5 ÷ 60 = 0.08333 min)

C = flow rate (difference between supply and demand, which may have a negative value)

For example: If T= 5 seconds then T = 5 ÷ 60 = 0.08333 minutes an if demand exceeds supply by 1500 SCFM then C = -1500

Then: $\Delta P = ((T)(C)(PSIA)) \div V = ((0.08333)(-1500)(14.5)) \div 4010.7 = -0.451$ PSI change in 5 seconds

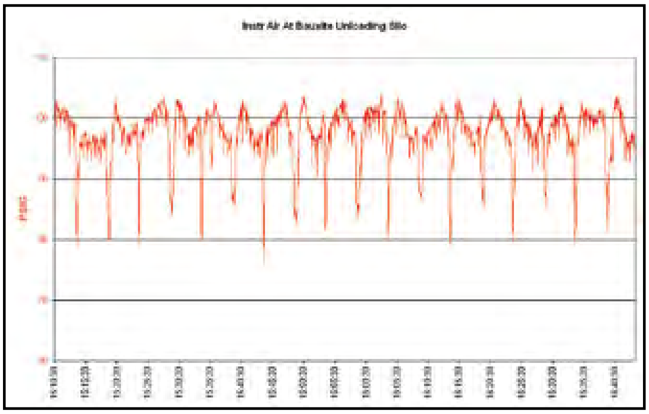
Control Valves

Pressure in the tank must be able to change for the tank to be useful. Meanwhile a stable pressure is desired in the plant. In this case, even with the addition of a large tank, we still needed a delta of nearly one Bar (14.5 psi), more than the change we wanted in the plant. Higher pressure increases artificial demand: and in this facility, that was having a significantly detrimental effect. Additionally, lowering overall system pressure is more difficult when it is not stable.

A flow control valve was designed and site-built to meet the situation where the flow rate would change rapidly and by a large magnitude. The valves (redundant arrangement) were selected for good control with a low-pressure loss (< 0.5 psi) at peak flow rates. We had already installed an excellent pressure transmitter as part of the permanent flow meter, and it was wired to the plant control system. We decided to use the plant's control system to control the valves as well. Once the valves were operational, we began to lower pressure in the plant and create the ΔP necessary to store the volume of air needed to meet the largest demand events.

Secondary Issues Surface

As soon as we began to lower pressure, the Low-Pressure Alarm on the Instrument Air System sounded, forcing us to raise it back up to 110 psig. Lowering pressure is essential to reducing both power costs and artificial demand, so we kept investigating. The Instrument Air System was supplied by the main system where we had lowered pressure about 10 psi. But the alarm was set another 15 psi below this point. In spite of its name, there actually weren't any instruments on this system. So we asked both why a desiccant dryer was needed to further suppress the dew point and what was causing the additional 15 psi drop that tripped the alarm. I installed a pressure transmitter and data logger. The data revealed that pressure was dropping sharply by 15 psi or more at regular intervals. The interval matched precisely the tower switching interval for this type of dryer, so we called a service technician and had the dryer repaired. We also walked the system. In doing so we found that the dryer served dust collectors and valve actuators located outside the heated spaces, and that the low dew point was to prevent frosting or freezing in the winter. Since this plant is in the deep South, I wondered how often the low dew-point was really needed. But at the very least, the dryer could be by-passed in the warmer months, eliminating the purge air requirement (pressure swing dryer).



Periodic Pressure Decay in Instrument Air System.

With the dryer repaired, Brian tried lowering pressure again. This time pressure was lowered to 80 psig where it was held until a problem with a group of dust collectors surfaced and pressure again had to be increased, although only to 90 psi. When Brian investigated the dust collector situation, he observed a pressure gauge indicating a drop greater than 40 psi. At high supply pressure, this situation went unnoticed. But at 80 psig, a pressure more appropriate for the plant, air delivered for back-pulsing the filter bags was not sufficient to cause the cake to be shed. High pressure had been compensating for a deficiency in the system. Regulators that had been installed to lower pressure for the dust collectors were restricting the flow needed to back-pulse. The dust collectors actually represented another instance of a high flow intermittent demand, and the resulting pressure fluctuations would be resolved with local storage. In the interim, the regulators, which were set at line pressure anyway, were removed and pressure was again lowered to 80 psig.

After successfully operating the plant at 80 psig for some time, pressure was reduced even further. It was lowered to 70 psig and held there until an issue with one of the transport systems surfaced. Again pressure was increased to 80 psig and the problem with the transport system will have to be investigated. When the demand side pressure requirement is finally determined the compressor control set points will be adjusted appropriately. For the time being they are set at 94 and 108 psig.

Compressor Controls

When the plant was running at 80 psig, compressors were unloading and turning off. Unfortunately, they would not stay off. The local compressor controls (provided as part of the compressor package), which were designed to communicate with each other and control the group as a system, kept restarting compressors when they weren't needed. At times, all six ran with two or more unloaded. We needed to be able to control the group so that that only one of them would run at part-load, and unnecessary starts would be eliminated. The factory-provided controls were failing to accomplish these tasks and needed to be "re-tuned."

COMPRESSED AIR AUDIT OF THE MONTH

Dense-Phase Transport Wreaks Havoc on Compressed Air System

Brian proved this by taking manual control of the system. He found that he could support pressure with just three compressors at full-load and a fourth lightly loaded until that worst case series of dense-phase transport events lasting over two hours occurred. (We were able to identify from our measurements that this series of events occurred three times daily.) It was during these periods that we experienced the highest and most dynamic flow, and controlling the system was most difficult. During these periods, the fourth compressor went to full load, and a fifth had to be started. While Brian's experiment actually provided more information than he realized at first, it definitely proved that the system behaved differently when under "intelligent" supervision. The local vendor was asked to make the adjustments. The network of local controls is now managing the system efficiently: only one compressor runs at part load, and at least one no longer starts at all. The shutdown timers were also adjusted to turn off compressors after just 2 minutes of running unloaded. This resulted in about two starts per hour for the trim compressor during the high demand periods and reduced unloaded run time by about 50%.

One other fact that became evident from this experiment was that another compressor could be turned off (leaving just 3 compressors on-line) if we reduced the demand by just a little more, about 350 scfm. Demand was already down because pressure had been lowered from 115 psig to 80 psig, reducing artificial demand, but little had been done to fix leaks or eliminate inappropriate uses of compressed air. Addressing these sources of waste should suppress demand by more than the 350 cfm needed to turn off this fourth compressor.

During his experiment, Brian had also observed that during the prolonged period of high demand, pressure on the supply side decayed slowly, and after about 15 to 20 minutes, a fifth compressor had to be started. But this compressor restored pressure in 15 to 20 minutes, suggesting that only half its capacity was needed. Reducing demand as described should be enough to keep this fifth compressor off-line during periods of high demand as well as keep the fourth compressor off-line — normally. But if not, we still had an ace to play. By talking with the Production Manager we had learned early on that this period of high demand resulted from an uninterrupted series of transport events. However, a small interruption (10 to 20 seconds) between the events could be tolerated, and calculations showed that interruptions even this short would make a big difference by reducing the average demand. The balance between supply and demand would shift in favor of supply, the pressure decay would be eliminated and the fifth compressor would not be needed.

Efficient Use of Energy

So, the big question: was this project worth the effort? At least one of the compressors has been turned off, so Brian's goal of providing a back-up compressor and sending the rental home has been accomplished. Plant-wide pressure is now very stable and at a much lower level, so the symptom of unstable pressure has also been resolved. But, wouldn't purchasing and installing another compressor have provided a simpler solution? No, because it would not have accomplished the same results. In fact it would also have increased energy cost.

First, let's look at unstable pressure which is symptomatic of a poor balance between supply and demand. Adding a compressor would have increased supply, true, but not until the new compressor was running and loaded. The signals to start and load, unload and stop, are based on changes in pressure. Pressure must change for compressor controls to respond and the changes must be large enough to keep them from responding to every little hiccup in the system. Experience has shown that a change of 10 psi works. In addition, if a compressor needs to be started, some time will pass before it can load and begin to support pressure. Typically, this is around 20 seconds for oil-flooded rotary screw compressors of this size. So, pressure will decay to the bottom of the control range, possibly by 10 psi, and then continue decaying for a while longer. When the compressor finally does load, the increased flow through shared air treatment equipment will result in an increased loss of pressure, aggravating the situation. Because there are a number of variables at work here, the total change in pressure will vary, but we can be certain of this: it will not be stable. Therefore, adding another compressor would not have stabilized pressure. The problem was not a lack of capacity, but a lack of control.

Adding another compressor would not necessarily have provided a back-up compressor either. By definition, a back-up compressor is not intended to support production on a regular basis. However, because pressure could not be supported with six machines, the seventh would have been called into service immediately and would have run almost continuously and not have solved this problem either.

In fact, not only would a seventh compressor have failed to solve the original problem, it would have resulted in higher costs due to less efficient energy use. Pressure in the system would have risen, increasing the cost of every cubic foot compressed, and we would have had to compress more cubic feet because artificial demand would also have increased. It is also likely that we would have realized an increase in unloaded run hours. Furthermore, another compressor would have meant additional maintenance costs. Because good data had been collected, Brian was able to make informed decisions about the best way to provide a back-up compressor and stabilize system pressure.

"Lowering pressure is essential to reducing both power costs and artificial demand, so we kept investigating."

Cost

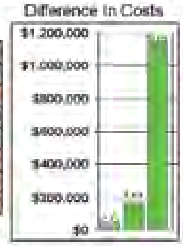
Was this project cost effective? Let's examine the issue by comparing the cost of implementing and operating the system with the engineered storage solution to what the costs would have been if a new compressor had been installed. While power and maintenance costs decrease when compressors are turned off, both costs would have increased if a seventh compressor had been installed. The difference is outlined below.

Clearly improving efficiency has advantages — in this case, an advantage of $143,000 in just two years and $1,145,000 over ten years. Decreases in power and maintenance costs make for the big impact. To sweeten this deal, compressor discharge pressure can be lowered, and it may be possible to turn off a third compressor for about 18 hours each day. These savings are not included. BP

Comparison of Costs: Engineered Storage Solution vs. Adding Another Compressor

Engineered Storage Solution	
Project Cost	$123,000
Power Cost* (Annual decrease)	($66,000)
Maintenance Cost (annual decrease	-15,200
First Year Total	$41,800
Cost / Year After First Year	($81,200)
Cost After Two Years	($38,400)
Cost After Ten Years	[illegible]

*based on 50% load



If a New Compressor Had Been Installed	
Project Cost	$50,000
Power Cost* (Annual increase)	$33,000
Maintenance Cost (Annual increase	$7,600
First Year Total	$90,600
Cost / Year After First Year	$40,600
Cost After Two Years	$131,000
Cost After Ten Years	$456,000

For more information please contact Brent Ehrlich, Air Services, tel: 336-751-4904, email: Brent@AirServicesSolutions.com

Real World Best Practices

by Hank Van Ormer

MATERIAL CONVEYING WITH PNEUMATIC AND VACUUM SYSTEMS

In many manufacturing operations, a very significant compressed air use is pneumatic conveying of many types of materials such as cement, fly ash, starch, sugar, salt, sand, plastic pellets, oats, feeds, etc. Often these are systems that use high-pressure air (100 psig class) reduced to lower pressures (15 psig, 45 psig). This creates an air savings opportunity.

These processes are often complex and engineered by the manufacturer to utilize high-pressure inlet air. To convert them to low pressure may sometimes be a daunting job requiring significant changes in controls, valves, piping, regulators, orifices, etc., so plants are often resistant to approach these opportunities as a serious project.

Our area of expertise does not lie in the design, application, selection or operation of pneumatic conveying equipment. It does lie in the area of identifying the operating cost of compressed air as an energy source and opportunities to reduce plant operating cost by effective management of compressed air power.

What is the relative electrical energy cost to produce 1,000 cfm of compressed air at various pressures (based on .05 kWh, 8,760 hours per year, and .93 ME)?

Table 7.

PRESSURE	APPROXIMATE HORSEPOWER INPUT	ESTIMATED ELECTRICAL COST
100 psig	220 hp	$77,295
50 psig	133 hp	$46,735
15 psig	92 hp	$32,355
7 psig	33 hp	$11,555

Dilute Phase Systems

The chart at left graphically shows the magnitude of opportunity that exists in electrical energy savings with **compressed air produced at the appropriate lower operating pressure instead of using high-pressure air volume (scfm) reduced to a significantly lower pressure (psig).**

The two most distinct categories of pneumatic conveying are low-pressure or high-pressure systems (there are other names "in between" such as medium phase, lean phase, positive pressure, etc.). The first category is low-pressure systems, also referred to as dilute phase pneumatic conveying systems. These systems utilize entry air pressure under 15 psig and use either positive or negative pressure to push or pull materials through the conveying line at relatively high velocities and volume. They are described as low pressure/high velocity systems and have a high air-to-material ratio.

A typical low-pressure system using a rotary air lock feeder will use a high pick-up velocity of around 2,500 fpm at the beginning of the system, and about 6,000 fpm at the end. The conveying line pressure is under 15 psig at the beginning and near atmospheric pressure at the end.

Low-pressure systems should use a low-pressure positive displacement blower as the primary compressed air source. Often, the abrasive nature of product being transported precludes the use of dilute phase and the associated very high velocities, which will create significant system piping and valve erosion.

Dense Phase Systems

The second category, high pressure systems, are known as dense phase systems. These systems utilize air pressure above 15 psig (up to 50 psig) in the pipe and use positive pressure to push materials through the conveying line at relatively low velocities (from 100 fpm to a maximum of 1000 fpm) much like extruding. They are described as high pressure/low velocity systems and have a low **air-to-material ratio.**

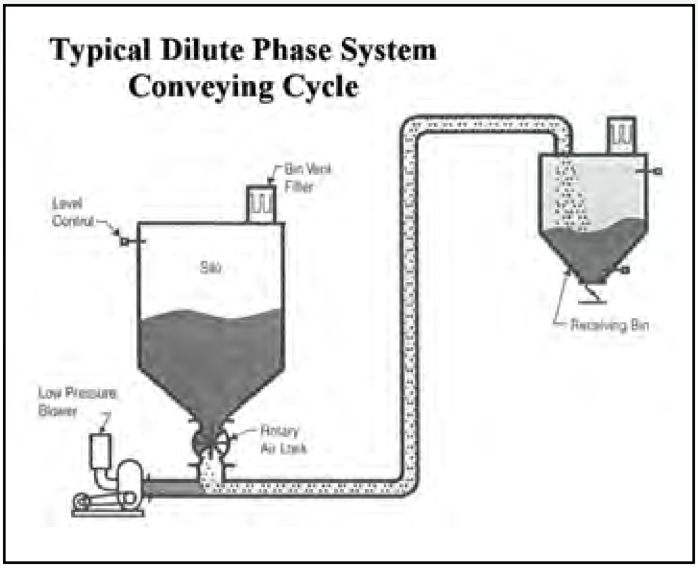
Dense phase conveying uses smaller amounts of air to move large amounts of bulk solid material in slugs through the conveying line.

Generally, the product being transported is often abrasive in nature. The Dense Phase system is selected to eliminate or minimize transfer pipe erosion, by maintaining the design's moderate velocities and still deliver the appropriate pounds per hour of production. Generally, this type of system requires an air compressor of the appropriate size and pressure (35–100 psig).

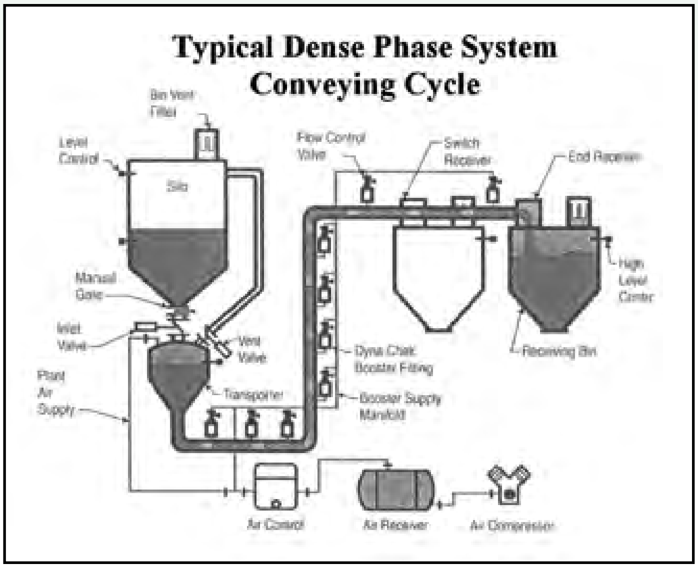
Dense phase conveying systems, if not already utilizing a dedicated lower pressure air supply, may be able to be taken off the high pressure systems and an appropriate single-stage reciprocating rotary screw or centrifugal (single or two-stage) compressor can be dedicated to this scenario. The electrical energy cost per scfm of this air will be much lower than the high pressure and the unit can easily be shut off when not in use.

REAL WORLD BEST PRACTICES

MATERIAL CONVEYING WITH PNEUMATIC AND VACUUM SYSTEMS



Typical Dilute Phase System Conveying Cycle



Typical Dense Phase System Conveying Cycle

These flow volumes will vary greatly depending on product and the system design, but they will always be lower than a similar dilute phase system. Often, these systems will have small booster pulsers along the transport path, which will add to the demand.

To evaluate the magnitude of potential savings once the required volume (scfm) is known, refer to Table 7.

When setting up a new conveying system, be aware of these opportunities to be sure your supplier and/or your consultant consider the true cost of air in basic designs.

Operating Air Fluidizers

The Dense Phase pneumatic conveying systems, particularly dense phase, use "booster pulsers," also known as "air saver boosters" or "air fluidizers," to help move the product along the line and free it from the piping walls. Multiple controls or fluidizers are typically installed through the wall of the hopper section and the wall of specific pipe runs to loosen the material and direct the air flow. Operating properly, they input short small shots of air, as required, to control the natural solidity of the product column and maintain appropriate compressed air pipeline velocity. The "air saver boosters" are usually carefully set and controlled to optimize the expensive high pressure air and not destroy the product column solid integrity.

These fluidizers are usually one of two types:

- Air blow only with separate vibrator
- Air blow with built-in vibrator

Here are some key tips to keep in mind when operating air fluidizers in your pneumatic conveying systems:

- Compressed air is your most expensive utility. If more air will not improve performance, identify and control the minimum volume of air to do the job correctly.
- Run the air only when the vessel is discharging. This not only will minimize the use of air, but also will probably improve performance. Running the fluidizers when the discharge is closed may create voids in the material. When the discharge outlet opens, the material may flow into the void rather than out smoothly.
- Try to run all multiple fluidizers sequentially, not simultaneously. This will significantly reduce the demand impact on the air system and help to hold the product together.
- Take the time to design the best possible timing of the pulsers. Get the discharge performance you need with the shortest possible pulse time and longest possible interval. If you convey different products, establish optimum timed pulse aeration for each product and adjust accordingly.
- Run electric-operated vibrators whenever conditions allow. If you have to run air-operated vibrators, be sure they only run when needed.

A Case Study

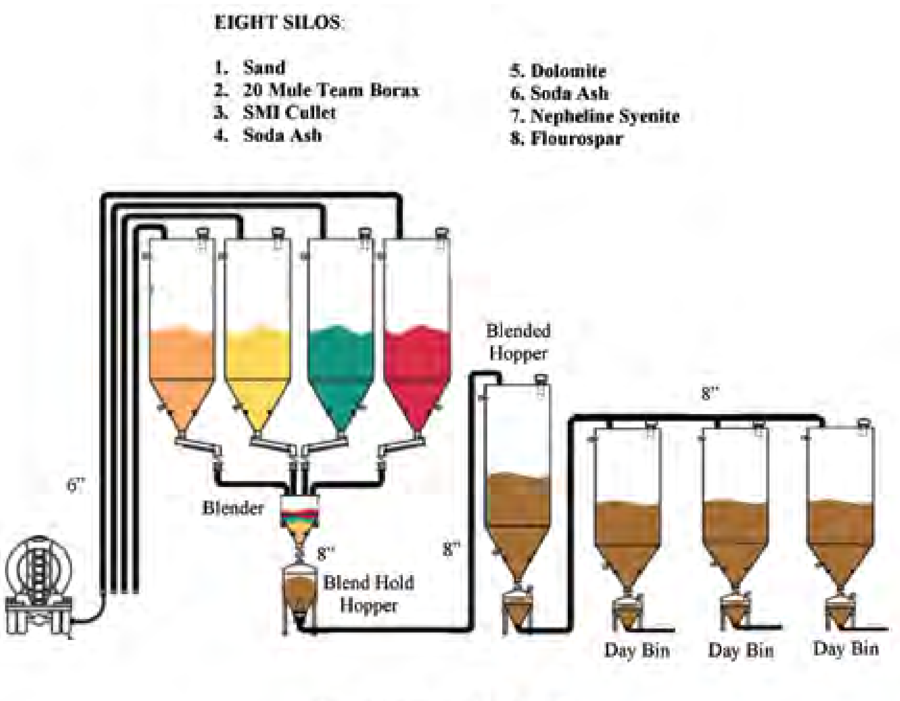
This case study is of an older material transport system, which shows some of the pitfalls in running a system without the proper controls.

The pneumatic transport system fills the eight supply silos with the appropriate material to be mixed and sent on to the furnace for production. Gravity feeds the material from the Blend Hold Hopper in the basement. The products are than pneumatically transported to two separate "Blender Hoppers" through 8" lines. These are for the two production lines. From the Blender Hopper, the mixed batch is pneumatically transported to three "Day Bins" for each line and then on to the furnace as required through 8" lines.

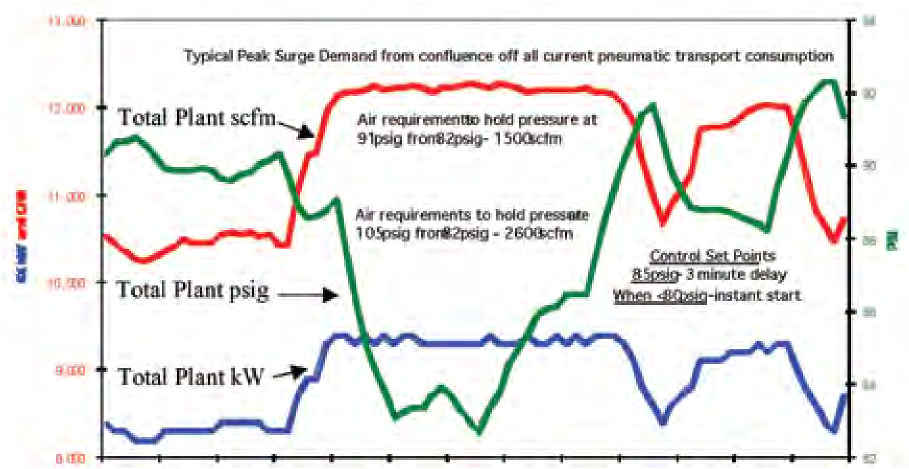
At the current production levels, the batch transporter system needs to constantly handle 30,000 pounds per hour of mixture. In order to establish a 2-hour cushion of supply in the Day Bins, the system must be capable of runs of 90,000 pounds per hour.

Over the years, in order to reach these continually increasing required transport levels, the basic system has been "adjusted," particularly the air savers or boosters. These boosters are all running open with feed pressures from 30 psig to 90 psig as adjusted.

Today, the measured average flow through the transport system is 1,500 scfm average (velocity up to 1,200 ft/min) and sustained peaks of 2,600 scfm (velocity 2,000 ft/min) for 2–3 minutes — 2,000 scfm for 6–8 minutes. These peak surge demands appear to occur at 10–45 minute intervals with five to six similar events during each hour.



Typical System Schematic



REAL WORLD BEST PRACTICES

MATERIAL CONVEYING WITH PNEUMATIC AND VACUUM SYSTEMS

The deep drops in pressure are caused by a lack of available compressed air at the time from the effects of the somewhat convoluted interconnecting pipe and the response time of the control system. The plant is experiencing significant pipeline erosion.

The transport system appears to be now consuming 1,500 average scfm with peaks to 2,600 scfm.

If the transport system can be run with a 55 to 60 psia main air supply to the transport pipe, there is a 112 kW average reduction in Primary compressed air input power and or electrical energy. At $0.10 kWh for 8500 hours per year, this would reduce the electric bill almost $95,200 per year annual electrical energy savings.

In order to implement, all piping, valving, etc, must be checked to see if they can still perform at this lower input pressure. At lower pressure, the piping may have to be bigger to avoid excess pressure drop. The air boosters if required could be tied to the high-pressure system, but they would have to be carefully controlled. It would be best if they can be fed from the low-pressure system with proper piping and regulation.

Vacuum Conveying

Vacuum pneumatic conveying has some inherent advantages compared to positive pressure pneumatic conveying:

As is always the case, each proposed process should be evaluated with total annual electrical energy operating cost as a key ingredient in the selection process.

Although vacuum is most often used in dilute phase transport, it can also be used in dense phase system when economics and conditions dictate. Careful evaluation should be implemented to the optimal power drives, particularly if a compressed air-driven central vacuum pump is planned to be used.

- **Dust control** — systems can be completely sealed from entry to discharge. Any leakage in the system will be internal, not into ambient work area
- **Minimum maintenance** — fewer moving parts mean a simpler system
- **Economical to operate** — often a properly applied vacuum system with an electric motor-driven vacuum pump will utilize significantly less electrical energy operating costs than a similar operating positive pressure system.

With a vacuum conveying system, an electric motor driven central vacuum pump should always be used from an energy efficiency standpoint. An air driven central vacuum pump starts out already "deep in the hole" with regard to energy efficiency. BP

For more information contact Hank Van Ormer, tel: 740-862-4112, email: hankvanormer@aol.com, www.airpowerusainc.com

Industrial Vacuum Cleaners Use Compressed Air

By Lisa Zocco

Buzzi Unicem USA's Pensacola terminal reclaims between 500 to 600 lbs. of Portland cement every other day using VAC-U-MAX air operated vacuum cleaners.

Without VAC-U-MAX's air operated vacuum cleaners, heavy cement must be shoveled away from boot seals and adjacent areas.

Portland cement companies combat heavy dust, reclaim product and enhance quality control using a variety of vacuum cleaning applications.

In an industry that has its roots in ancient Roman times, and turns mountains into dust with rugged equipment that pounds, crushes and grinds, a vacuum cleaner seems almost unnatural — a little domestic. However, with recent supply shortages and tighter EPA and OSHA regulations, Portland cement manufacturers are finding vacuum cleaners to be the ideal solution to reclaim product and comply with health and safety regulations. As a result, industrial vacuum cleaners are being used in nearly every step of the manufacturing process, from the cement plant to the lab, in loading and unloading terminals, as well as in bagging operations.

Each step in the manufacturing and distribution process has its own pains and thus requires unique solutions. In the lab environment, a little dust is a big problem and may require a dedusting system for quality control measures, but a cement plant that spans many floors and produces one thousand pounds of dust per day may require a central vacuum system with a piping network to each floor. For bagging operations where dust is difficult to control, a continuous duty vacuum system is ideal; and in areas where spillage is minimal, like loading and unloading stations, a single portable air-operated vacuum may be sufficient for periodic clean up.

in Portland Cement Manufacturing Processes

Industrial vacuum cleaners that would make Tim "The Tool Man" Taylor green with envy are more sophisticated than their cousin, the shop-type vac that has been labeled "asthmatic" when up against the savage conditions in the cement industry.

"We tried shop vacuums, but they just wouldn't last," says Andy Rodgers, Terminal Manager at Buzzi Unicem USA's Pensacola, FL terminal. "The dust just eats everything up and the motors don't last."

Air Operated Vacuum Cleaners and Clean Up for Railcar Unloading

The Pensacola terminal unloads Portland cement from bottom dump railcars into silos via a boot connector with foam seals. The boot-seal connects hopper-car unloading gates to a pit where a screw conveyor transfers cement to bucket elevators that dump into the silos.

"Sometimes these foam seals blow out, they start leaking or maybe one of the boots will drop and then cement will hit the ground instead of in the pit," says Rodgers. "The shop vacuums weren't powerful enough to clean up five to six hundred pounds of cement so we used a lot of shovels and wheelbarrows."

When Rodgers was searching for a more effective method of clean up, John White, VP Logistics at Buzzi Unicem USA, suggested he look at a Belleville, NJ-based VAC-U-MAX that introduced the first air operated vacuum cleaner in 1954. White was familiar with the company from earlier in his career and said, "the company said that you could pick up a bowling ball with it and we actually tried it once and it really worked!"

What impressed Rodgers most about the industrial vacuum was that it is powered by air and not electricity. "All these terminals have air compressors," he said. "Air operates our valves; it operates our boot connectors, that is how we move the material — by air."

The air-powered vacs operate on the Venturi principle and by design create their own vacuum without motors or moving parts, making them intrinsically safe and ideal for use with abrasive cement particles that can damage electrical equipment over time. "It works perfect for these big terminals."

Rodgers is only one of 31 Buzzi Unicem USA terminal managers who have a competitive tradition of tracking who has the cleanest terminal. After presenting his solution at last year's annual meeting, the competition escalated. "That next week, I had 30 emails asking me where I got this thing."

INDUSTRIAL VACUUM CLEANERS USE COMPRESSED AIR IN PORTLAND CEMENT MANUFACTURING PROCESSES

Buzzi Unicem USA's Indianapolis terminal uses the MDL-55 air operated vacuum cleaner, with pulse jet filter, from VAC-U-MAX to clean up excess flyash and slag around boot connectors.

Dissatisfied with using brooms, shovels and air hoses that just blow around debris, Mike Glaze, Terminal Manager at Buzzi Unicem USA's Indianapolis, IN terminal that unloads fly-ash and slag, was the next to get VAC-U-MAX's MDL 55. "We use it for several different things here."

Like the unit in Pensacola, Glaze's unit is mounted on a dolly with wheels that enables it to be moved around easily. "We clean our bucket elevator, our screw conveyors and use it to clean around our boot seals," he says. "It's really handy and easy to use."

The unit has a unique pulse jet filter cleaning system that, with the push of a button, back-washes the filter eliminating the need to manually clean the unit, virtually eliminating clogging. Glaze says, "Like anything else, if you take care of it, it will last a long time. You just push a button on top of the vacuum mechanism to keep the filters clean."

Glaze also appreciates that using ear protection is not necessary with the unit. "There is just no noise to it all." The units are equipped with noise mufflers and guards for sound levels below 80 dbA. Rodgers from Pensacola agrees. "You don't even know this thing is running unless you put your hand on the end of hose."

Beyond the friendly competition of keeping their terminals clean, reclaiming hundreds of pounds of material each day is important to the terminal managers. "That was one reason we wanted this, because the barrel was so easy to maneuver around," says Rodgers.

We just vacuum it up, roll it over to the pit and put it right back into the system. We don't lose anything."

Central Vacuum Systems and Clean Up for Bulk Transport Loading

Buzzi Unicem USA is sensitive to environmental issues and is proactive in adhering to OSHA and MSHA regulations as well as local EPA guidelines. As such, the Stockertown, PA plant utilizes two VAC-U-MAX Monobloc centralized vacuum systems to remove product build-up around the hatches of bulk tankers and railcars that are loaded from above, ensuring no dust is spread when the trucks are leaving the facility or traveling through neighborhoods.

These stationary Monoblocs include strategically placed piping throughout the facility enabling hoses to be connected to clean multiple areas simultaneously.

Centralized vacuums are also used in clinker plants early in the cement manufacturing process and capture a half ton of dust per day during the grinding process. In large grinding operations with multiple floors, the vacuum is centrally located on the ground level with piping routed to each floor for easy clean up.

Centralized vacuums are also used in more sophisticated environments where continuous duty is essential for quality control purposes.

Continuous Duty Central Vacuum Systems for Quality Control in Automated Labs

In automated labs where constant operation of multiple stations and materials produce fine, smoke-like dust, vacuum systems can easily become overwhelmed, skewing test results. In order to maintain accurate results, automated labs require central continuous duty vacuum systems that are precisely engineered.

Considerations such as floor space, pick up points, collection capacity, the need for manual vacs and other parameters must be weighed. When Lehigh Cement Company's European-made central vacuum system wasn't performing as well as expected, the company turned to VAC-U-MAX. The company sent an engineer, along with a demo truck equipped with a 20 HP vacuum, to perform an audit and make recommendations that delivered desired results.

Continuous Duty Vacuums for Bag Filling Reclamation

Continuous duty vacuums, although less sophisticated than the central vacuum systems used in the lab, are also used to capture and reclaim cement in the bagging process.

In cement bagging operations, it is difficult to avoid dust spillage. Texas-based Featherlite uses a VAC-U-MAX continuous duty vacuum to avoid product loss with their bag filling machines. The unit captures the spillage and puts it back into the packaging machine to maximize profit.

In rugged industrial applications where environmental safety, ergonomics and productivity matter, vacuum cleaners designed specifically to withstand harsh 24/7 operation can deliver consistent performance that adds to a company's bottom line. BP

To read more about VAC-U-MAX solutions in the cement industry, visit www.vac-u-max.com and click on case histories on the vacuum cleaning page or contact us at 1-800-VAC-U-MAX (800-822-8629); email info@vac-u-max.com

"Each step in the manufacturing and distribution process has its own pains and thus requires unique solutions."

THE NUMATICS AIR PREPARATION GROUP

Compressed Air Best Practices interviewed Mr. Don Swanson (President) of the Numatics Air Preparation Group (APG).

Don Swanson, President of Numatics APG

Good afternoon. Can you give us a brief history of Numatics APG?

Numatics was founded in 1945 by William Carls, which began manufacturing pneumatic components for automated machinery. By 1952, Numatics gained a worldwide reputation for the innovation and development of the billion cycle lapped spool and sleeve air valve. The rugged air valve design quickly became the industry benchmark for precision and performance.

As Numatics established a leadership position in the supply of pneumatic and motion control products, manufacturing facilities in North America and Europe were established. To support Numatics' rapid rate of growth, strategically located sales and service organizations were opened throughout the Americas, EMEA (Europe-Middle East-Africa), Latin America and Southeast Asia. Today, Numatics is recognized globally for the supply of pneumatic valves, air cylinders, control systems and air preparation equipment.

When was the Numatics APG started?

To expand core competencies from plant floor automation to other areas within the manufacturing environment, Numatics made several investments, including two strategic acquisitions. In 1988, Numatics invested heavily in the development of a comprehensive series of point-of-use filters, regulators and lubricators (FRLs). In 1992, Numatics acquired Micro-Filtration, a manufacturer of high-performance filtration media. We acquired Ultra-Air Products, a manufacturer of desiccant and refrigerated compressed air dehydration technologies, in 1994.

Numatics APG in Lapeer, Michigan

In 1999, Numatics established the Air Preparation Group, comprised of Numatics FRL, Ultra-Air Products and the Micro-Filtration brands. We manufacture our products in our 42,000-square-foot facility in Lapeer, Michigan. An experienced staff of 74 employees is dedicated to the design, manufacture and support of Numatics APG air preparation products.

Numatics was acquired by Emerson in 2005. How has the acquisition benefited Numatics APG?

To strengthen its existing fluid-power-automation capabilities, Emerson, a diversified global technology company that serves a variety of industries, acquired Numatics APG in September 2005 under its Industrial Automation business unit.

Emerson maintains 265 manufacturing locations around the world; it's through this global reach that we now have access to new markets and vast engineering and technology resources that enhance our cost position and product performance.

We also benefit from Emerson brand names familiar to industrial and commercial consumers. Recognized household brand names, such as InSinkErator and ClosetMaid, are Emerson companies. Sealmaster, Browning and Copeland are all well-known Emerson brands with products serving the industrial market. ASCO and Numatics APG both reside in the Industrial Automation Group of Emerson. Our mission is to leverage Emerson's success and establish each of the Air Preparation Group products as prominent, well-recognized companies.

Emerson Brand Names:

Copeland®

ASCO®

CLOSETMAID

IN SINK ERATOR®

Numatics APG customer service team Debby Butler, Toni Craig, Jennifer Werth, Jeannie Wilcox, Heather Pung, Pam Schlaud, Melissa Tomkins (left to right).

THE NUMATICS AIR PREPARATION GROUP

How is Numatics APG positioned in the market?

We want our customers to think about us differently from other suppliers they deal with. We view our size and opportunity resources as a distinct advantage. Our size enables us to be free thinkers and react quickly to challenges while remaining flexible in the pursuit of new opportunities. We're uniquely positioned to satisfy special product requirements while meeting the everyday needs of our customers. We are a relatively small company possessing big company capabilities.

Our goal is to be known as the air treatment company that offers solutions and is easy to do business with. When a customer calls the front desk at our Lapeer operation, they'll be greeted by a human voice. This subtle, yet personal touch reflects how important we feel the customer is.

The depth of products the Numatics APG manufactures separates us from the market. We are capable of providing supply-side dehydration and filtration equipment, flow controllers, as well as demand-side air treatment products. Our one-source supply saves our customers money and valuable time.

Speed — not only a timely response to customer inquiries, but also in terms of product delivery — provides market differentiation. Our company stocks quick-moving refrigerated and desiccant dryers, FRL's and a full assortment of compressed air filters to meet the immediate needs of our customers. We want our customers to come to us for all their air treatment needs.

What is the scope of the product offering?

Ultra-Air products are marketed through compressed air house and fluid power distribution sales channels. Our distributors enjoy access to a complete line-up of compressed air dehydration and filtration equipment.

The Ultra-Air product strategy is to add new, innovative technology to an already comprehensive product portfolio. We also design products delivering on-going aftermarket opportunities and provide our customers unique energy-saving solutions. The Ultra-Air product portfolio includes:

- Three refrigerated air dryer platforms, covering cycling, non-cycling and high inlet temperature designs. Flows of refrigerated air dryers range from 10 to 21,000 scfm.
- Desiccant air dryers include four platforms, from heatless, externally heated, externally heated blower purge to vacuum purge assist designs. Flows range from 10 to 5,000 scfm, with dew points delivered down to -100° F.
- Compressed air filters are available from ¼" npt to 16" flanged connections, with six filtration levels to select from. Compressed air filters are offered in cast aluminum, polycarbonate, stainless steel and ASME coded pressure vessels. Canadian Registrations Numbers (CRN) have been assigned for all major provinces in Canada.

Numatics FRL building an electronic proportional regulator, Micro-Filtration assembling a filter element, Ultra-Air building a 201 Series dryer (left to right).

Micro-Filtration products are marketed through instrumentation, HVAC and industrial distribution sales channels. We manufacture custom filtration media and complete filters for compressed air, fluid processes, oil and gas applications and instrumentation industries. Micro-Filtration also manufactures more than 10,000 direct replacement compressed air filter elements for more than fifty original equipment manufactures. Our capabilities include the design of custom filter housings, from highly engineered thermo-plastics to stainless steel. Producing our own elements and housings has allowed us to expand beyond traditional compressed air applications. Examples include HEPA (High Efficiency Particulate Air) and ULPA (Ultra Low Penetrating Air) filters for COPD patients utilizing oxygen, ventilator equipment, CO monitor filters, emissions analyzers and other critical to function applications.

"Our one-source supply saves our customers money and valuable time."

The Numatics FRL brand is marketed through fluid power and compressed air distribution channels. We offer a full line of high-performance air-preparation equipment for protection of pneumatically operated equipment. The lightweight aluminum designs are attractive to both end users and OEM's.

Filters, regulators and lubricators are available from 1/8 to 2 NPT/BSP meeting flow requirements of our diverse customer base. Regulators are available from standard product to more sophisticated electronic proportional designs. The Numatics FRL offering allows us to satisfy customer requirements from the generation of the utility, through the compressed system, to the point of use.

NUMATICS AIR PREPARATION GROUP

Numatics APG engineering team: Alex Cherviovskiy, Scott Menko, Kan Hom, Jay Dalal, Mike Brown, John Ball (left to right).

Please describe your manufacturing and engineering capabilities.

The Numatics APG possesses extensive manufacturing capabilities complimented by an experienced workforce. Products are designed globally, using parametric CAD software on common servers. We use a sophisticated computer program called "Numasizing" to assist customers in optimizing component selection, which ultimately helps reduce costs in both components and compressed air usage.

An environmental test chamber validates new and existing designs to ensure optimal performance in real-world conditions. All products undergo a battery of tests prior to shipment. For example, each refrigerated dryer goes through a 30-step qualification process. Each unit is pressurized with nitrogen then leak tested. All portions of the refrigeration system are checked. The units are energized with the integrity of the electrical system inspected.

Compressed air filter elements are manufactured through a proprietary vacuum formulation process. A laser particle counter verifies element performance and integrity of the seals. A comprehensive test and quality control program is in place for all filtration product lines. Filters are pressure tested for leaks around critical sealing points. Sonic and spin welding equipment is used to manufacture custom filters employing thermoplastic housings.

Our in-house manufacturing and performance validation allows us to control the process from start to finish and maintain full ownership of product performance.

In conclusion, what can customers expect from Numatics APG in the future?

We don't think of ourselves strictly as a supplier, but as technology partners for our valued customers. We will remain committed to providing custom solutions, continuous improvement in our designs and in the development of new, energy saving technologies. We will keep pace with the changing market and technological advances.

Thank you for your insights.

For more information, please contact Don Swanson, Numatics Inc., tel: 810-667-3900, email: don.swanson@emerson.com , www.numatics.com

THE INS AND OUTS OF VACUUM GENERATORS

BY DOCTOR VACUUM

As an auditor, compressed air vacuum generators are one of my favorite topics. These are devices that utilize compressed air to generate vacuum and have become an easy target in compressed air system studies. There are a number of factors that should be considered before these devices are either put in place or left in place. The reality is that there is an enormous population of vacuum generators being used successfully by industry. Applications range from pick and place to vapor extraction to bulk material handling and the number of installations is growing. Before proceeding with an installation utilizing these devices, there are two general issues to consider: efficiency and appropriateness.

Efficiency

The efficiency issue is very clear. While I cannot say that electric-driven vacuum pumps are always a more energy efficient choice, I personally have yet to find a vacuum generator application that I couldn't make more efficient by going electric. The pick-up in efficiency when switching from compressed air driven vacuum to electric-driven vacuum ranges from two to fifty times. A good rule of thumb average is that electric- driven vacuum pumps are four times more energy efficient than compressed air-driven vacuum generators. These kinds of numbers tend to make energy managers take serious notice of the potential savings, and as the costs for energy continue to rise, any approach to trim energy cost is important.

There are a few general operating characteristics that tend to make efficiency better or worse for venturi-style vacuum pumps. The first is operating vacuum level. The higher the required vacuum, the lower the comparative efficiency. If you only need a couple of inches of mercury, you are in far better shape (using vacuum generators) than if you need 22" of mercury. The second characteristic is high flow at high vacuum. Those applications that require high flow rates at higher vacuum levels are going to be far less efficient than electric-driven vacuum pumps that can deliver similar capacity. The efficiency gap closes somewhat in circumstances that require high flow at low vacuum. Also, any application that requires constant vacuum flow is typically better suited for electric vacuum pumps.

A significant advantage for electric vacuum pumps is found in the central compressed air supply area. Compressed air-driven vacuum pumps each use quite a bit of compressed air; for proper operation

THE INS AND OUTS OF VACUUM GENERATORS

A good rule of thumb average is that electric-driven vacuum pumps are four times more energy efficient than compressed air-driven vacuum generators.

and facilities with large numbers of these devices may have issues maintaining adequate supply pressure. These facilities will typically have several "extra" compressors online to maintain site pressure requirements. Replacement of vacuum generators with electric vacuum pumps will allow for large horsepower compressors to be taken off-line and be replaced with much smaller horsepower vacuum pumps. An average example would be taking a 100 horsepower air compressor off-line and replacing it with a 25 horsepower dedicated vacuum pump. The associated compressed air filters and dryers will also be shut down. Not only are there energy savings in this case, there are also savings for maintaining smaller pieces of supply equipment. As an added benefit, it is far easier to maintain site compressed air pressure with a lower demand requirement.

Appropriate in Contaminated Atmospheres

When considering the appropriateness of using vacuum generators there is not as much clarity. In applications where there are a large number of vacuum generators in a small floor area, it is much easier and economical to use a centralized vacuum system. However, in applications where there are just a few vacuum generators in a large floor area, it is not as practical to use electric vacuum pumps especially if compressed air is the only pneumatic supply within a reasonable distance. If adequate electrical service is not locally available, adding sufficient electrical supply may be an expensive endeavor. In processes where mobility is needed, vacuum generators are as equally mobile as electric-driven vacuum pumps and can be much smaller in physical size.

In applications that generate corrosive vapors, venturi-style vacuum pumps are a viable choice given their simplistic design and ease with which varied materials of construction can be used. Environments with heavy particulate loads, especially where particles are very small, seem to lend themselves more to these types of systems. This is in part due to the filtration requirements of many electric vacuum pump designs. When a majority of particulates are smaller than one to five microns in diameter filtration systems tend to become relatively large for an electric vacuum pump.

Designs for vacuum generators have been changing in recent years and they are definitely more efficient than they used to be. They have also become less sensitive to compressed air supply pressure. Older designs required high pressure for normal operation. When supply pressure dropped, so did performance. New designs also incorporate energy saving controls to shut off the compressed air supply as needed and vacuum sensors to detect when parts are not present on robotic arms. These types of advancements open up more applications for vacuum generators and make them appropriate for other uses.

The end result is that if energy reduction is your aim, finding alternatives to vacuum generators is a prudent course. Otherwise, it seems that vacuum generators are one of those sinful conveniences that many owners know about but are not willing to do without. I believe the reason is that these devices can be so versatile and capitally inexpensive that the energy downside is swept aside or not measured at all. Whether efficiency or appropriateness is more important, each vacuum generator should be individually evaluated to ensure it is the best technology to do the job. BP

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DEKKER VACUUM

Compressed Air Best Practices interviewed Rick Dekker (President & CEO) of Dekker Vacuum Technologies.

Rick Dekker, President & CEO of Dekker Vacuum Technologies

Full plant audits of vacuum systems are a growing trend.

Good morning! Please share the history of Dekker Vacuum Technologies.

Good morning. The roots of our company start with my father, Jan Dekker, who was heavily involved with oil-sealed liquid ring vacuum systems used in the gold mines of South Africa. This was in the mid 1970s when gold prices were going up. Vacuum systems (in the mines) were optimized by improving vacuum levels using oil instead of water and by adding vacuum boosters. He then came to the United States in 1979 to open up a vacuum division for Sullair. I joined him in 1993 as an application engineer with a different company until we founded Dekker Vacuum in 1998.

Why did you start Dekker Vacuum?

When we started Dekker Vacuum, we saw an opportunity because the vacuum industry was very old-fashioned in how it serviced its customers, both before and after the sale. Customers complained about mediocre customer service levels, parts availability, after-sales technical support and repair.

Dekker was therefore founded with a strong focus on providing excellent customer service before and after the sale. This philosophy has hit home with customers and has driven our strong sales growth over the years. The firm reached profitability after only twelve months of operation and the Company has now reached $12 million in annual sales. In 2007, Dekker was listed on the Inc. 5000 list of fastest growing companies in America. We are headquartered in Michigan City, Indiana in a 45,000 square foot manufacturing facility.

Please describe the management philosophy at Dekker Vacuum.

My father (Jan Dekker) is one of the worlds' leading authorities on vacuum applications. I also began my career as a vacuum applications engineer. When my father sold his shares to me in 2004, I was faced with a decision of whether to focus on management/leadership or to become the "vacuum guru" like my father. I realized I couldn't do both. We decided that I should focus on the strategic direction of the company and to assemble an "A-Team" in management, while ensuring that the organization receives the tools and support required to be successful.

Meanwhile, our vacuum expertise in application engineering has flourished through the leadership of our Vice President Jerry Geenen, the applications engineering group and the continued involvement of my father as a consultant and advisor. Jerry is an integral part of the organization and we wouldn't' be where we are today without him.

My strategy has been to find the best people we could afford. We now have an "A-Team" in place, which allows me to focus on strategic direction and providing management with the appropriate tools and resources to be successful. I have learned that leadership is about helping people do their jobs better by providing them with the appropriate support, guidance and freedom in order to do so.

What are some of the strategic directions of Dekker?

We started a formal strategic planning process three years ago and we now update it every year. We promote three core values within our company, which have helped us create a distinct company culture. We have made a lot of progress with this and we continually check our decisions based upon them. When addressing customer issues and problems, these core values are our guide. To provide the highest levels of service to customers, for example, we ask ourselves, "Is this decision in line with our core values?"

The three core values are:

1. Integrity
2. Excellence
3. Innovation

Please describe innovation as a core value.

A company always has to be innovative to survive in today's business environment. We focus on providing innovative vacuum solutions to customers. When reviewing a customer's application, we focus on the best solution for their application rather than focusing on trying to sell a given product to that customer.

If we don't have the right product, we will let them know. We have focused on educating the sales engineers and the customers on application and product knowledge. Education is the key to providing innovative customized solutions for our customers.

Vacuum flash evaporator for Biofuel applications.

Multi-stage vacuum pump systems use a combination of system components to meet customer requirements cost-efficiently.

DEKKER VACUUM

VmaxVFD Variable Frequency Drive oil-sealed liquid-ring vacuum system used in the medical and woodworking industries.

Most of the systems that we design and manufacture require a level of innovation. Dekker is an engineering company, heavily invested in application and design engineering. Each customized application essentially involves designing a new product. Customer satisfaction is extremely high when we are able to tailor a solution for them, rather than offer them a standard product. Innovation also takes place within our organization to create the most efficient processes to handle our day-to-day business.

We are also investing in a pipeline of exciting new products. They involve new control schemes and dry (oil-free) vacuum technologies.

What markets do you serve?

We are in many markets but to name some of the big ones — plastics, woodworking, medical, general industrial, power generation, chemical, petroleum and pharmaceutical.

AquaSeal PowerGen condenser-exhauster two-stage liquid ring vacuum system used for Power Industry to reduce main turbine back pressure.

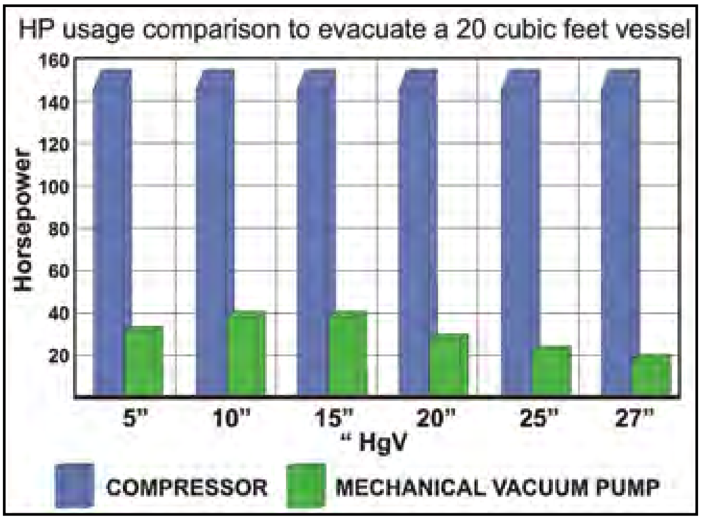
Where are the energy efficiency opportunities with vacuum?

At Dekker, we are very committed to energy efficiency. One of our primary areas on focus has been in promoting the use of variable frequency drives (VFD's). We have sold close to a hundred systems with VFD's. The woodworking industry, with CNC routers, is a good example. As you start routing a board, you are creating leakage as the router cuts through the plywood board on the router table. The more you cut, the more leakage you create and the part can slip, which increases scrap rates. As you create more leakage a VFD system will ramp up the speed of the vacuum pump to keep the part from slipping, reducing scrap. Energy consumption is also reduced due to the elimination of across the line starting and speed turn down when idle.

Another application is in the power plant industry. Upgraded vacuum systems can improve the efficiency of the turbine by reducing back-pressure. This is accomplished by removing the air leakage in the condensers. Customers may realize energy savings between $250,000 and $1 million per year. Savings are naturally dependent on a number of factors, including condenser cooling water temperature and the age or type of vacuum equipment currently in service.

The use of VFD's requires a certain level of electrical integration, especially when multiple VFD's are used such as in Hospital applications. At Dekker, we have a dedicated electrical engineering department, which has developed proprietary control algorithms. Such a focus on electrical engineering is somewhat unique in our industry. This department is also developing some exciting, innovative products that will be launched in the coming year.

Full plant audits of vacuum systems are also a growing trend. Piping networks have pressure drops and leaks like in compressed air distribution systems. Many machines using vacuum are not receiving it at the optimal pressure. Centralized vs. de-centralization issues — there are a lot of opportunities out there.



Industry can save thousands of dollars by shutting down an air compressor and switching to mechanical vacuum pumps.

We also suggest that all packaging companies using venturis (air ejectors) should examine the benefits of switching to mechanical vacuum pumps. While the benefit of a venture is no moving parts, the energy inefficiency overshadows that benefit. Venturis require a lot of compressed air to create vacuum. Using a mechanical vacuum pump will require ¼ to ⅛ the energy used in creating vacuum with a venturi and compressed air. From an energy efficiency perspective, this is very easily justified.

Power Plant customers may realize energy savings between $250,000 and $1 million per year with upgraded vacuum systems.

What is the scope of product offering?

Our product range is from 2 acfm to 28,000 acfm. Vacuum levels range from 10 inches of mercury to 1 Tor. We offer liquid ring and rotary vane vacuum pumps and systems. The rotary vane pumps are both dry and lubricated. The dry pumps are truly dry pumps, with no oil in the vacuum pump. We have found a lot of issues in the market as suppliers try to deliver "oil-free" dry vacuum pumps. Most "dry" pumps out there still end up with some oil in the pumping chamber as oil migrates from the gearbox through the seals into the pumping chamber.

To help us serve our customers better, we stock over 1,000 pumps and 85% of bare pump orders ship within 24 hours. We have a full metal fabrication workshop for base plates, tank fabrication and Section 9 pipe welding. We design, fabricate and assemble the complete systems and perform the electrical work and controls programming. Every system is full tested prior to shipment to ensure a satisfied customer.

Thank you for your insights.

For more information please contact Rick Dekker, Dekker Vacuum Technologies, tel: 888-925-5444, email: rdekker@dekkervacuum.com, www.dekkervacuum.com

Do Your MEETINGS

BY DON SCHMINCKE

Don Schmincke

It's yet another weekly management meeting. Everyone shows up, sits down and takes their turn in reporting progress on assigned projects. At first glance, this looks like a great way to ensure accountability for performance, but could it be sabotaging your company's future success?

How can this be? Surely something as simple as meeting to track performance is basic MBA 101 on how to run a company, right? Well, some CEOs disagree. By challenging the assumption about these types of meetings they've found something remarkable — competitive advantage.

It's not that tracking performance is wrong, but there are other ways to issue status reports on projects more efficiently. Email, intranets and old-fashioned paper can allow data to be absorbed more quickly than verbal presentations at meetings. Why not use the invaluable time in management meetings for what we wish we had more time for — solving problems?

This sounds great except for one snag — the problem is we don't like revealing problems! We'd rather reveal our "great performance." Divulging our problems could make us look weak or incompetent, or diminish our demonstration of "brilliance" to those who could promote us. More so, it could open us up for retaliation or manipulation!

Of course there are organizations where these could be real fears, but cultures like these have deeper problems than ineffective use of management meetings. For the rest of us, using meetings to share and solve problems versus displaying our "great performance" may offer a better opportunity to improve such performance.

Examples of organizational successes using this methodology are buried in the literature, from examples of "skunk-works" projects to the recent success of Toyota. For example, one manager at the Toyota Georgetown plant used his time in management meetings to demonstrate his good performance on projects he was assigned until plant manager Mr. Fujio Cho (now the Chairman of Toyota worldwide) said to him, "We all know you are a good manager, otherwise we would not have hired you. But please talk to us about your problems so we can all work on them together." Of course, the rest is history now that Toyota has surpassed GM. Could it be that Toyota's meetings were different than GM's?

Focus Meetings on Problems Versus Performance

Meetings which focus on problem-solving versus reporting on good performance seems to offer companies key benefits such as:

More efficient use of time: Time is scarce and getting scarcer. Companies that use face-to-face time for problem-solving exploit the power of human dialogue versus wasting it on monologues. They create solutions and address decisions on the issues that matter. Project status reports are important but this one-way data can be transferred using other more efficient means. Time is money. Where do you want to spend it?

Higher motivation: Solving problems generates more positive energy than status reports do. Celebration and acknowledgement of good performance should be done, but in more meaningful ways then self-proclamation in short slots of meeting agendas. When a strong staff is free to expose real issues and work on them, it pulls the team together and lessens the effect of demoralizing egos on the organizational agenda.

Profits: It doesn't take a rocket scientist to figure out how Toyota got to the top. Continuously seeking improvements by finding and resolving problems enhances competitive advantage in any market. Tolerating a culture that avoids this in order to "look good" or satisfy personal interests guarantees a dramatic financial failure. This has toppled the largest of companies, some whose executives are now facing prison time.

Sabotage Your Profits?

Make it Happen in Your Company

Shifting your company's culture to embrace problem-solving meetings can be tough. It takes more than an e-mail announcement or a speech. Some ideas include:

1. Assess management meetings you are now attending and determine if they really are necessary. If not, distribute data or information from those meetings using other methods.

2. If the meeting is important, shift the agenda from focusing on performance accolades to sharing and solving problems.

3. Challenge those who "don't have problems." Are they playing hard enough? Are they holding their cards too close to the vest?

4. Notice the level of defensiveness in the culture. Are people "coachable"? Can they disclose issues easily? Can they take feedback without it seeming so personal?

5. Start leading by example. Surface your problems first! This last idea could be difficult, but it shows you are serious. And it allows you to start challenging the group. Start asking questions like:

   - "Even though we are performing well, what's not working or can be improved in your department?"

   - "What is your greatest personal challenge or concern we should be talking about today?"

   - "Where in your area are you having the most problems?"

"Time is money. Where do you want to spend it?"

This doesn't mean that project performance status shouldn't be on the agenda. A few accolades can be appropriate, but surfacing and focusing on problems and projects that are off-course so that the group can work together on resolving them is critical for sustaining competitive advantage and profits.

Is this something that everyone is ready for? No. It requires a strong, confident staff. Only solid teams thrive in an open and supporting culture. On the other hand, weak teams don't have the courage to disclose their issues and accept help. But then, if that's the case, perhaps you have another problem. BP

ABOUT THE AUTHOR

Don Schmincke is a business consultant and author of the CEO bestseller, "The Code of the Executive." A graduate of MIT and Johns Hopkins University, Don uses anthropology and evolutionary genetics to dispel the usual management and leadership techniques. With more than 20 years of research and consulting experience, Don and The SAGA Institute help companies accelerate performance. He has worked with the U.S. Navy Fleet Readiness, DuPont, IBM, Miller Brewing and more. For more information, call: 1-866-LEAD-866 or visit: www.sagaleadership.com.

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TITLE	SPONSOR	LOCATION	DATE	INFORMATION
Advanced Management of Compressed Air	Compressed Air Challenge®	Oak Brook, IL	2/27/2008	www.compressedairchallenge.org
Fundamentals of Compressed Air	Compressed Air Challenge®	Omaha, NE	5/6/2008	www.compressedairchallenge.org
Advanced Management of Compressed Air	Compressed Air Challenge®	Omaha, NE	5/7/2008	www.compressedairchallenge.org

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Wall Street Watch

BY COMPRESSED AIR BEST PRACTICES

The intent of this column is to provide industry watchers with publicly held information on publicly held companies involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information gathered in this column was on January 9, 2008.

CHARLOTTE, NC — December 31, 2007 — SPX Corporation (NYSE: SPW) today announced that it completed the acquisition of APV, a global manufacturer of process equipment and engineered solutions primarily for the sanitary market.

"The acquisition of APV greatly enhances our process equipment operations serving key markets around the world, particularly in Europe and Asia Pacific," said Chris Kearney, Chairman, President and CEO of SPX. "With APV's broad spectrum of proven process solutions, rich heritage of innovation and wealth of engineering expertise, we are better positioned than ever to capitalize on the growing global demand for flow technology products and solutions," he added.

APV was previously a division of Invensys PLC, an international industrial automation, transportation and controls group headquartered in London. APV's primary products include pumps, valves, heat exchangers and homogenizers for the food, dairy, beverage and pharmaceutical industries.

SPX first announced that it had entered into a definitive agreement to acquire APV on October 31. APV will be operated as part of SPX's flow technology segment.

Quincy, IL — January 03, 2008, Gardner Denver, Inc. (NYSE: GDI) announced the appointment of Barry L. Pennypacker as its new Chief Executive Officer and President. Mr. Pennypacker succeeds Ross J. Centanni, who has served in these capacities since 1994 when Gardner Denver became an independent, publicly traded company. Mr. Pennypacker will report to Mr. Centanni, who will remain the Company's executive Chairman of the Board. It is anticipated that Mr. Pennypacker will join the Company in his new role on January 21, 2008. In addition, he will be appointed as a member of the Gardner Denver, Inc. Board of Directors in February 2008.

Mr. Pennypacker joins Gardner Denver from Wabtec Corporation (NYSE: WAB), a provider of technology-based equipment and services for the rail industry worldwide, where he served as Vice President, Group Executive since 2002 and Vice President, Performance First from 1999 to 2002. Prior to that, he was Director, Worldwide Operations for the Stanley Fastening Systems operating unit of Stanley Works from 1997 to 1999. Mr. Pennypacker also served in a number of senior management positions of increasing responsibility with Danaher Corporation from 1992 to 1997. He holds a Bachelor of Science Degree in Operations Management from Penn State University and a MBA in Operations Research from St. Joseph's University.

Regarding Mr. Pennypacker's appointment, Mr. Centanni stated: "I am very pleased that Barry has decided to join Gardner Denver. He is an outstanding leader who has the qualities and skills required to ensure the Company's continued profitable growth. I am confident that Barry is the right person to help Gardner Denver pursue and achieve its strategic objectives in the future."

Mr. Pennypacker also offered: "I look forward to new challenges with Gardner Denver, an organization with a rich heritage and tradition, and an equally bright future. There is a great foundation from which we can build as the Company strives to become an even larger and more profitable organization. I feel fortunate and excited to have the opportunity to be a part of Gardner Denver's future success."

Hamilton, Bermuda and Piscataway, New Jersey, December 17, 2007 — Ingersoll-Rand Company Limited (NYSE:IR) announced it has executed a definitive agreement to acquire Trane Inc. (NYSE:TT), formerly American Standard Companies Inc., in a transaction valued at approximately $10.1 billion, including transaction fees and the assumption of approximately $150 million of Trane net debt. Trane is a global leader in indoor climate control systems, services and solutions with expected 2007 revenues of $7.4 billion.

Under the terms of the merger agreement, which has been approved by the Boards of Directors of both companies, Ingersoll Rand will acquire all outstanding common stock of Trane. Holders of Trane's approximately 200 million common shares will receive a combination of $36.50 in cash and 0.23 Ingersoll Rand shares of common stock per each Trane share. The total value for this transaction was $47.81 per Trane share based on the closing price as of December 14, 2007. The transaction, which is expected to close late in the first quarter or early in the second quarter of 2008, is subject to approval by Trane shareholders, regulatory approvals and customary closing conditions.

Herbert L. Henkel, Ingersoll Rand Chairman, President and Chief Executive Officer, said, "The combination of Ingersoll Rand and Trane will create a global, diversified industrial company with projected pro forma 2008 revenues of $17 billion. The new Ingersoll Rand portfolio will include an $11 billion Climate Control business which will offer high-value equipment, systems and services necessary for delivering solutions across the temperature spectrum for indoor, stationary and transport applications worldwide."

WALL STREET WATCH

"As a result of expected revenue and cost synergies, we are confident that this acquisition will improve Ingersoll Rand's future earnings growth potential. We believe the new Ingersoll Rand will be capable of sustaining annual organic revenue growth averaging

5 to 7 percent, and EPS growth exceeding 15 percent per year, both in excess of our former growth guidance. In particular, assuming timely consummation of the proposed acquisition, we anticipate earnings of $4.00 per share in 2008."

Fred Poses, Trane Chairman and CEO said, "For our shareowners, this offer represents an attractive price for our shares today and the opportunity to participate in a powerful global diversified industrial company in the future. Combining Trane and Ingersoll Rand's climate control operation creates a very strong business. With the size, strength and operational effectiveness of a $17 billion global industrial company, we believe this combination is best for our customers, employees and shareowners in the long term." Poses will remain in his position until the acquisition is completed.

"This acquisition represents a significant next step in Ingersoll Rand's decade-long transformation to become a leading global diversified industrial company, with strong market positions across the climate control, industrial and security markets," said Henkel. "The acquisition of Trane meets our long-term objectives of significantly increasing consistency of revenue and income streams, adding strong brands and market positions, and further strengthening the organic growth potential of our portfolio. Trane's leadership position in the global commercial and residential climate control industry enhances our own highly regarded Hussmann and Thermo King brands."

"Trane's demonstrated long-term organic growth rate, averaging 7 to 8 percent per year, compares favorably to the organic growth targets we have established for our business portfolio. Trane's talented management team and employees have delivered consistent revenue growth and operating margins throughout all phases of the business cycle.

"We believe Trane will deliver strong growth and profitability going forward. Based upon market fundamentals such as rising energy costs and conservation initiatives, we expect solid replacement-demand for energy-efficient products and for retrofit and refurbishment of current systems. Trane's large installed base of equipment and systems will provide profitable aftermarket growth potential. Also, Trane has the leading market position in North America, and is growing strongly and increasing penetration in international markets."

"On a combined basis, Ingersoll Rand's climate control operations are projected to have revenues of approximately $11 billion in 2008 and will have a significant presence in all major segments of the associated industries worldwide. It is anticipated this combination will produce annual pre-tax cost and revenue synergies exceeding $300 million by 2010. Anticipated synergies include purchased material savings through supplier rationalization and procurement leverage, improvements in manufacturing costs and lower general and administrative costs. Longer term, we will benefit from synergies related to cross selling and service revenue expansion."

New York, December 13, 2007 — United Technologies Corp. (NYSE:UTX) During a meeting with analysts today, United Technologies Corp. President and COO Louis Chênevert affirmed the company's expectation for 2007 earnings per share growth of 14 percent, or a range of $4.22 to $4.25 per share. Chênevert also projected 2008 earnings per share of $4.65 to $4.85, growth of 10 to 14 percent. The company anticipates 2007 cash flow from operations less capital expenditures in the range of net income.

"UTC will have a solid finish to 2007, and we continue to expect earnings per share growth of 14 percent for the year," said Chênevert. "Strength in aerospace and commercial construction markets more than offset continued deterioration in the U.S. residential HVAC market. Cash flow from operations less capital expenditures will be in the range of net income, in spite of inventory growth to support the ongoing strong organic revenue growth.

"We expect another year of solid performance in 2008, as UTC's strong portfolio of market leading businesses and experienced management team continue to deliver outstanding results. UTC is uniquely positioned to capitalize on continued worldwide growth with more than 60 percent of revenue generated outside of the United States. Prospects for future earnings growth are fueled by our ACE operating system, which is driving productivity improvements across our businesses. We also see strong market acceptance of UTC's new products across our entire portfolio from Otis' Gen 2 to Pratt & Whitney's Geared Turbofan engine," Chênevert continued.

Revenues are expected to increase to $59 billion in 2008 on mid single digit organic growth with solid operating profit growth in all six businesses. We expect cash flow from operations less capital expenditures to equal net income in 2008. Share repurchase is expected to be $2.0 billion for the full year. BP

JANUARY 9, 2008 PRICE PERFORMANCE	SYMBOL	LAST PRICE	1 MONTH	6 MONTHS	12 MONTHS
Parker-Hannifin	PH	$66.01	-16.8%	2.2%	33.3%
Ingersoll Rand	IR	$39.98	-20.8%	-25.2%	4.3%
Gardner Denver	GDI	$30.49	-9.9%	-28.4%	-11.7%
United Technologies	UTX	$71.79	-4.4%	2.9%	19.1%
Donaldson	DCI	$41.50	-9.8%	19.3%	25.3%
EnPro Industries	NPO	$26.70	-10.8%	-37.0%	-13.0%
SPX Corp	SPW	$95.11	-8.2%	6.1%	58.6%

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Hitachi America, Ltd. in Charlotte, NC has Sr. Service Specialist position in their Air Technology Group. Responsibilities include: execute and manage areas of warranty, customer service, service administration, product updates, resolve product issues, ensure distributors are properly trained, initiate field service calls, assist in tracking product quality, help to differentiate products and qualify add-on services/products to create customer value. Serve as liaison to Japan and be first point of contact for all technical inquiries for Distributors, OEM and Strategic Accounts.

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