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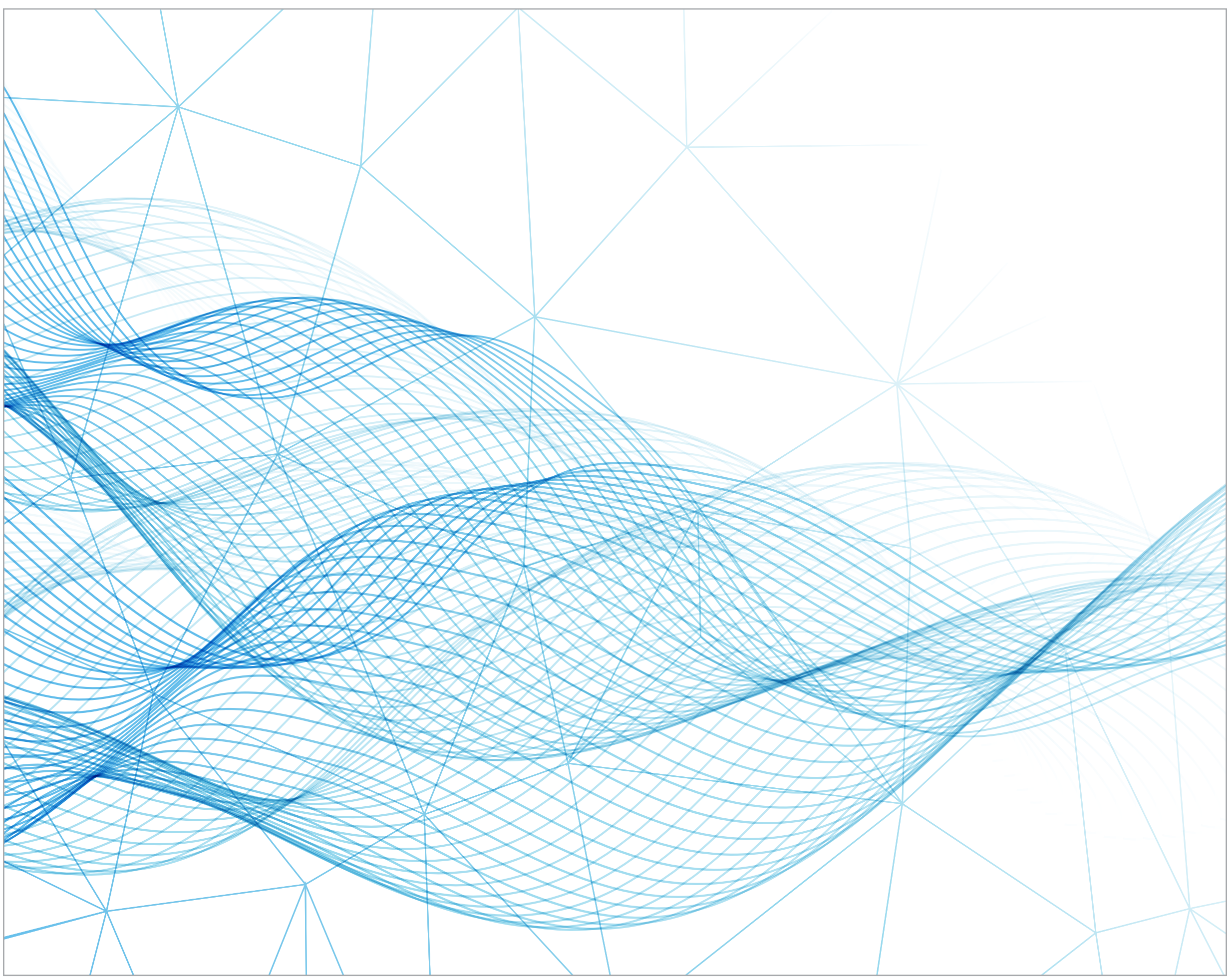
Which compressed air system design is right for you?



When good compressed air equipment goes bad

by Ron Marshall

Over the years, many well-meaning companies have taken advantage of utility incentives to upgrade their compressed air system for premium efficiency. Sure, the new equipment costs more to buy, but the additional costs are usually paid for through lower electrical costs, or so you were promised. But sometimes things go wrong: Equipment is not set up correctly or malfunctions occur shortly after installation, for example. If you don't have proper monitoring equipment or monitoring strategies in place, you may not receive the savings you expected.

To prove your savings, you must ensure that you or someone competent measures your baseline pressure, energy, and flow to capture your plant profile before your project, so that you'll be able to compare against the conditions after the project. When the project is complete, the baseline must be recaptured and savings calculated in the same manner.

Sometimes you won't achieve the expected savings. There can be many reasons for this, and having some accurate baseline numbers can help you sort it all out and possibly troubleshoot and fix the issues. Some common problems:

- New equipment doesn't operate correctly because of settings problems
- New equipment has failed or energy savings features have not been correctly activated
- Plant flows have changed
- Plant pressure has increased,
- Significant new leakage has occurred
- There are seasonal changes in the plant flow, and the baseline was captured during different conditions
- One or more production shifts has been added.

An example of one or more of these points comes courtesy of a wire manufacturer who during a plant tour proudly displayed his new variable-frequency drive air compressor. The compressor control had a screen that showed a histogram of the number of hours the compressor had spent at different percentage loading. The information collected showed the unit had been at 100% load for all of its operating hours - a very poor application of this technology. The customer had no idea, and presumably the salesperson who sold the compressor and set it up had no clue either. A simple change in the compressor pressure settings solved this issue.

Another example was with a food processor that purchased an expensive high-efficiency desiccant air dryer when its plant was built. Many years later, after experiencing constant problems with the dryer, a compressed air auditor placed monitors on the system and discovered efficiency problems. A careful inspection revealed that the dryer had been assembled incorrectly and had never worked properly in the first place. A simple change to the wiring solved this problem.

During my time with a power utility, it was my job to verify the correct installation of new energy-efficiency equipment, and doing pre and post-monitoring headed off many of the problems listed in the bullet points. I found that it's always best to expect the unexpected and check your installation both before and after some major work is done. Make sure you measure as you go along so you can ensure you're getting what you paid for. If something isn't up to snuff, you'll be able to prove that corrections are required.

You can get help with this by calling a reputable compressed air service provider - preferably someone who has attended a Compressed Air Challenge level 1 or 2 seminar. Learn more about compressor monitoring at Compressed Air Challenge's next Fundamentals of Compressed Air Systems seminar. Check out the calendar at www.compressedairchallenge.org.

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Before retiring in 2016, Ron Marshall was the industrial compressed air systems expert at Manitoba Hydro, where he worked for 38 years. His efforts supported the organization's Power Smart Performance Optimization Program, and he now operates his own compressed air energy efficiency consulting firm and is a member of the project development committee at the Compressed Air Challenge. Contact him at ronm@mts.net. ◻

Which compressed air system design is right for you?

Consider more than just initial cost when selecting the air compressor system for your plant.

◻ When purchasing an air compressor, overall system efficiency can be an important part of the decision-making process, considering that energy costs can be up to 76% of the overall lifetime cost of these pieces of equipment. However, equipment costs, maintenance costs, and installation costs, as well as the size of the compressor room and a location of the compressor room to already established utilities, can heavily impact the decision-making process, too.

In a recent Plant Services webinar, Neil Mehltretter, engineering manager for Kaeser Compressors explored compressed air system design and how it impacts energy efficiency. Some of his key tips are listed below:

SINGLE UNIT SYSTEM

Single compressor installations are typically the lowest capital cost when compared with multiple compressor installations, which can be advantageous, says Mehltretter. "Let's first look at an installation of a single compressor. A single fixed-speed compressor will have a lower capital cost when compared with a single variable-speed compressor."

However, one thing that always comes up in any system design is the cost of backup or redundancy. With a single compressor design, the cost of a backup compressor is equal to the single compressor. It all comes down to the pros and cons.

"On the pro side, you have a simple installation, a smaller footprint, one power connection, one pipe connection, and a simple operation with a single pressure band," says Mehltretter. "On the con side, what happens when the single compressor isn't operational? Absolutely nothing; the plant won't be able to run. Often the lost opportunity cost due to

downtime over one year could exceed the capital cost of purchasing a backup compressor."

MULTIPLE UNIT SYSTEM

A simple alternative to the single compressor station is two fixed-speed compressors, each rated for 50% of the total system demand. In this case, says Mehltretter, "the pressure band increases slightly so that we can cascade the units. The capital cost for a multi-compressor system will be higher than a single compressor. But instead of adding 100% of a compressor as a backup, we could consider a third 50% compressor as a backup. Therefore, redundancy is a lower capital cost."

The primary benefit of multi fixed-speed compressors is the lower cost of adding redundancy. This type of installation also provides better efficiency at lower demands than a single fixed-speed compressor. "Maintenance intervals are traditionally based on service hours of the compressors," says Mehltretter. "Therefore, if we have multiple smaller fixed-speed units, we can stretch out the operation, balancing those service hours between all those compressors. This typically results in more predictable service intervals with all the compressors coming due at the same time, saving multiple trips."

The multiple fixed-speed compressor installation will typically require more physical space at your facility, and it will need more utilities such as power and water, and infrastructure such as piping. Also, with more compressors, the overall project will typically cost more.

SPLIT SYSTEM DESIGN

The final model involves a split system design: a variable-speed drive compressor, which represents about 60% of the overall demand, running in combination with a smaller fixed-speed compressor, which represents about 40% of the overall demand. A pressure range of about 15 PSI will ensure that both compressors aren't going to be loading and unloading together. "This will require a slightly larger fixed-speed compressor as a backup," says Mehltretter, "hence the medium redundancy cost designation. You'll also be looking at a medium installation cost designation as variable-speed drive compressors are more expensive than their fixed-speed counterparts."

A split design system will typically be the most efficient system type: it will provide for redundancy should the variable-speed drive be offline for any reason, and it's typically a lower capital cost than a single variable-speed drive system. Alternatively, the split design will have a higher capital cost than the 100% fixed-speed compressor or the multi-unit fixed-speed compressor.

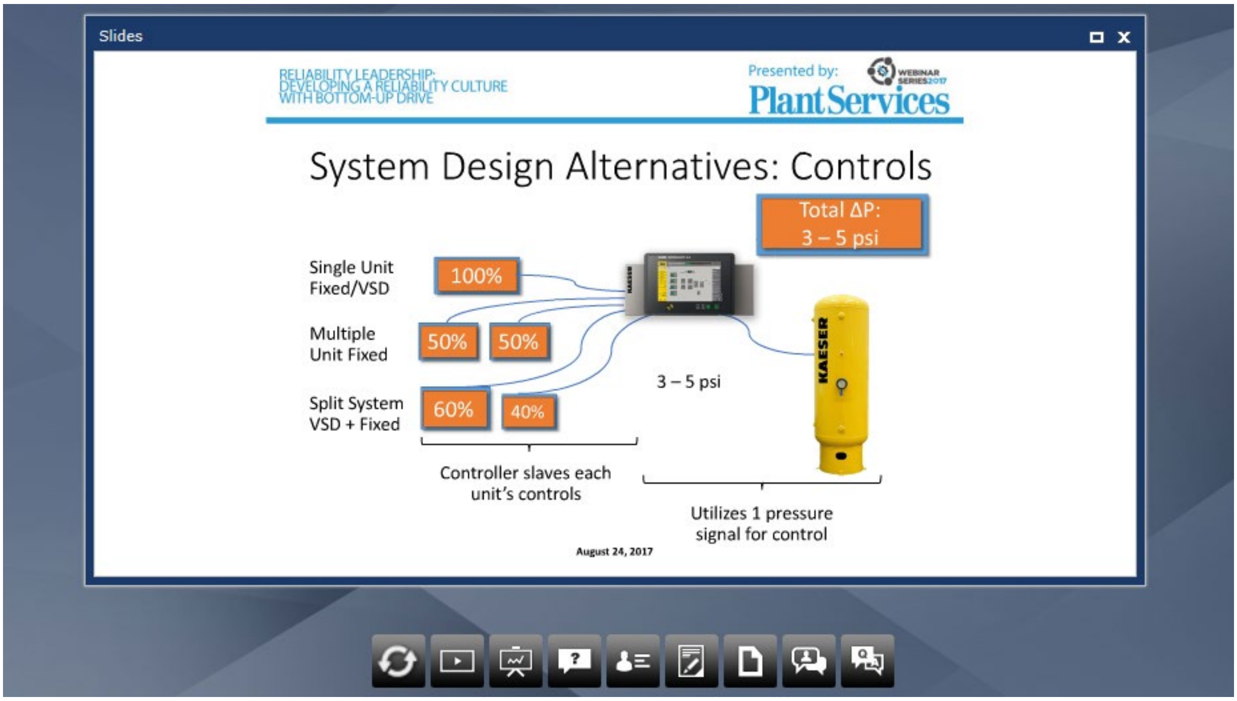
"The goal of any system design is to maintain the best possible efficiency for the entire demand range," adds Mehltretter. "We often see facilities scale up or down over time, and these changes could happen quickly without the ability to procure new compressors. Those facilities that size, in this kind of step design or split system design, are able to maintain their efficiency levels very closely regardless of the demand."

SYSTEM CONTROL

The next level of compressed air system efficiency is to deploy either a flow controller or a master controller to help ensure that multiple compressors aren't loading and unloading at the same time. With a cascade pressure band, says Mehltretter, you're going to be operating at higher pressures. "We know, as a rule of thumb, that one PSI is equal to .5% power. So the higher the pressure you operate, the higher the overall energy consumption will be."

Flow controllers are a useful tool in the field to drop the network pressure to the lowest possible level. These controllers address artificial demand, as flow controllers regulate pressure to the distribution piping. In systems where there are or were multiple modulating compressors, the flow controller also is a great way to reduce overall energy consumption. However, often the generation pressure, the pressure at the compressors, must remain at a higher level to create the needed buffer for the flow controller to work. The flow controller also doesn't control the compressors, only the downstream pressure. "This matters because we aren't capitalizing on the improved efficiency of those compressors," says Mehltretter. "With cascade pressure and the needed reserve buffer in a storage receiver plus a little differential for the flow controller itself of 2 to 3 PSI, we have a total differential pressure from the compressors discharge to after the flow controller of anywhere between 17 and 28 PSI. That's a very large pressure swing to consider."

In contrast, a master controller will be able to coordinate all the compressors within the system. When a master controller is installed and there are multiple smaller compressors, efficiency can be optimized resulting in the lowest operating costs. When compared to flow controllers, they are more expensive, can have significant installation costs, and don't have an explicit reserve capacity like a flow controller creates. However, a master controller typically works with a much smaller pressure band (in general, 3 to 5 PSI).



"Newer master controllers on the market are based on algorithms that consider rate of change calculations versus simple pressure band controls, learning the station and making simulations for the most efficient operation," says Mehltretter. "Master controllers also can be accessible remotely and stream data and message to plant operators in real time."

To learn more about compressed air system efficiency and design, watch the on-demand webinar.

https://info.plantservices.com/compressed-air-systems-optimization_ca