Compressed Air Controls: Simple to State-of-the-Art

Developing an action plan (Part 2 of 3)

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Key concepts

- **Define and prioritize expectations from control improvements**
- **Outline the existing system and its shortcomings**
- **Small, fast starting compressors can replace large, slow ones**.

If compressors are sized incorrectly, regardless of controls, if the capacitance is not adequate for the events in the system, or if the demand is not managed, nothing will help a system operate properly.

Whether buying a new system or retrofitting an existing one, there are a number of things that can be done to ensure success. Success is applied, not bought. Automating a poorly defined problem will yield an automated problem.

Getting control project approval

Define what results the organization wants from the system. Every element of management will have different expectations. These need to be clearly prioritized for the operator of the system, the production user of the air, and the financial decision-maker in the organization.

In most cases, the system has been operated manually or by staging existing compressors with their local controls. The people managing the system have done the best they can with what was available and with a limited knowledge of alternatives. They have met vague requirements, which were developed perhaps a decade ago.

It is not unusual that the operating philosophy is "keep them running and avoid a failure at all costs." This type of philosophy was acceptable under another business climate. It was also developed when there may have been extremely limited alternatives.

Make it clear to all of the players that the business climate has changed and has new priorities. Everyone should enter this exercise with an attitude of amnesty, moving forward from this point, not finding blame for the circumstances of the past. It will be difficult to investigate the existing circumstances if any of the players feel defensive or if they will be held accountable for any problems that are uncovered.

Define expectations

Don't head into this or any other project without first defining the group's expectations and priorities. Do this up front. Remember that a great control solution with unlimited demand will fail. Get production and management involved early and agree on what is to be accomplished.

Reduce the operating cost of the system. **What does it cost now, and how much cost and/or energy must be reduced?**

Improve the accuracy and repeatability of the system as it impacts production quality. **This pertains to pressure and air quality. What are specific needs and how accurately can these goals be achieved on a continuous basis?**

Improve the reliability of the system. **Define the frequency and impact of interruption resulting from the compressed air system. How does the system fail? When there is a component failure, how does it impact the system? What is the tolerance level for failure, duration, percentage of curtailment, and frequency per year?**

This is rotating equipment. It's not a question of if it will fail, but how much and how often per time period. 0% tolerance usually results in 50[en]100% more capital and significantly higher operating costs.

Is there a demand-limiting strategy for supply curtailment? Is there a dependency on in-house or outsourced expertise to determine problem definition in the absence of quality information from trendable metering? Does the system have sufficient information to make users accountable for the quantity of air they use and how they use it?

Depending on the answers to these questions, it is possible that no solution will produce a desired result.

Cost

Is the capital to achieve the desired end results available? What are the rules of engagement? Is there a return on investment, return on structured risk, or return on assets expectation? Once defined, how important is it compared to the other interactive priorities?

Whether the system doesn't meet performance expectations or the goal is to reduce operating cost, build a business case financially and back it up with properly engineered facts. There isn't much money available in today's business environment, be it discretionary or capital return, for "making it better." Many companies have a desire to reduce their operating cost.

In many cases, the system works poorly at best. Make the system meet minimum expectations before it can be efficient. Both exercises cost money, but only one will produce a lower cost. This can be a challenge for a capital return on investment project. If there is no engineering or financial expertise or metrology to build the case, hire a professional organization to prepare this.

In today's market, virtually everyone will claim this expertise. Thoroughly check out everyone's credentials including references. Have they retrofitted or designed solutions that have been implemented and achieved the desired end results in your type of production process?

System definition

Define the system up front before approaching a solution. There are some problems that need to be understood before approaching a solution regardless of how large, small, or complex the system is. If there are no answers to these system issues, a control solution may not be feasible.

Where are the control signals in the existing arrangement? Does each compressor have it's own discreet signal? Are they in different locations on each compressor relative to its components? One compressor may have its signal upstream of the aftercooler, while the others are downstream.

Does one of the compressors have a signal downstream of the dryer? If the individual compressor signals are inputting the controls from different locations, it's virtually impossible to get the compressors to work together.

What is the quality of the signals to the compressor controls? Is there water or oil in the signal lines? A liquid head can change the signal and foul the controls. Are the pressure transmitters in the signal-to-controller arrangement accurate and calibrated? Can they be calibrated? If they are rated at 0[en]200 psig and 2% repeatable, there could be a 4-psig variation across the signal inputs to each compressor control.

If the deviations from compressor control to compressor control are not known, it is not possible to know how to adjust the control set points to get the compressors to work together properly.

What are the differentials across the aftercoolers, filters, and dryers? Was the system designed for the resulting differentials? Where are the differentials relative to the signals? The differentials will change as a square function of flow. If the signals are located upstream of the differentials, the differentials will change the signals.

Without understanding and measuring the signals, range of differentials across the load conditions, and set points, there is no chance of getting the system to function reasonably regardless of the controls approach.

How long does it take for each compressor in the supply to start and get to full displacement? This is called the control permissive. It can take between 6 and 180 sec. depending on the type of compressor, how sensitive it is to cooling, the complexity of the microprocessor if any, and the type of starter and motor. The larger the compressor, the longer or slower the control permissive speed from signal to full load. Without this knowledge, control storage cannot be properly sized or some of the more sophisticated control platforms used.

If microprocessor controllers or analog gauges are on the compressors, are the readouts and/or gauges calibrated? If not and they are used for adjustment or diagnosis, how can they be expected to ever get the equipment to work together properly or diagnose a problem properly?

What is the range of demand volume that is needed for all of the conditions experienced, including the lowest load and possibly no-load? What is the breakdown of usage per condition quantifying base load and trim? This information will help in determining the size of the compressors required.

Most systems are designed based on the highest load for compressor size selection. This usually leads to the selection of compressors that are too large for the system. This results in what appears to be a need for a more sophisticated control solution to get the larger-than-necessary compressors to operate efficiently despite the circumstances.

Because the compressors are too few, too slow to react, and too large, none can be shut off. Proper analysis would determine that replacing one of the larger compressors with smaller, faster units and a well selected controls approach would create the best solution with the best return on investment. This arrangement beats a compromise controls solution to get a poorly configured arrangement to work better.

What are the events that transiently hit the system from time to time? Is there a process blowing application, car unloading, retorts, large dust collectors, air testing, flat bed filters, filter presses, or other large limited-time applications? They could range from low volume, short cycle, high rate of flow to high volume, 5[en]10-min. applications, at high rates of flow.

The key to understanding these tough applications problems is what impact they have on the system, its energy, operating cost, and other competing applications. They typically represent the reason the systems' pressure drops to its lowest point from time to time. Conversely, it is the reason that most systems are operated at much higher-than-needed pressures.

The dilemma is the cost of operating the system part loaded with too much energy most of the time. The solution is not to figure out a control scheme that will make the part-load energy of too many compressors operate better. The solution is to define and deal with the problem, not massage the symptoms.

Begin by measuring the events in real time. Track down the culprit by tracking pressure decay to the user and define the events. Measure the capacitance of a limited portion of the system, isolate it, and operate the event relative to time. Then answer all of the required questions. It may be necessary to temporarily connect a supplementary tank for this test if there is a drop below the minimum pressure for the event.

How effectively is the total demand controlled in the system? Are there regulators at all points of use including applications such as hand-held or stationary blowing? Are many of the regulators adjusted to the wide-open position? What percentage of the total demand is represented by leaks? Even if the answers are estimated, is more than 10[en]15% of the total demand uncontrolled?

If this is the case, when the pressure rises to unload energy in the control system, that portion of unregulated demand including waste will increase by volume reducing the positive rate of change. This will either slow down or prevent the ability of the control system to unload power in the system.

The higher the percentage of unregulated usage, the more difficult it will be to operate the compressor control solution. It is not unique to have 50% of the total demand by volume unregulated. With this frequently being the case, prior to the development of central demand controllers, constant-pressure compressor controls made a lot more sense than using a dead band or throttling band to operate the system and manage the demand pressure in the system.

What is the lowest pressure that can satisfy demand all of the time? What is the particular application that drives this need? Investigate and measure the differential pressures or the event associated with this application to see if it can be reduced in pressure without sacrificing the article pressure or effectiveness of the production or process requirement.

Find the next lowest operating pressure requirement. That is the pressure the demand system will get. Evaluate the cost to correct the highest pressure requirement, to the next lower pressure, and evaluate the cost to do this verses the savings potential on the supply side of the system. Most of the time the system can be reduced by 10[en]20 psig for less than 1% of the cost alternative to operate or elevate the supply pressure to achieve the same results.

In most cases, it involves reducing differential pressure or providing dedicated storage to reduce the pressure drop. If this isn't easily achieved, dedicated supply is usually an inexpensive alternative compared to operating the entire system at the elevated pressure and energy required.

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