

TECHNICAL BRIEF

Technical Brief on System Controls for Industrial Compressed Air Systems

Proper Controls Improve Productivity Through More Stable Air Pressure and Lower Energy Costs

Most industrial facilities depend on compressed air and have specific pressure, flow, and purity requirements. Yet meeting these requirements without careful planning can be wasteful, as compressed air is an expensive utility. There are many opportunities that exist to reduce air system operating costs and compressor controls should be considered in any energy cost reduction initiative.

The purpose of any compressor control system is to match the compressed air supply to the demand as efficiently as possible. There are two levels of control: controls for individual compressor units and higher-level controllers that integrate an entire air system installation of multiple compressors and possibly other components like filters, dryers, flow control valves, and drains.

At both levels, controls address three main facets of system operation:

- How well they deliver sufficient variable flows to achieve stable pressure at points of use
- How efficiently they run the compressor(s) with respect to energy consumption
- How well they track and communicate operational data (e.g., status, maintenance hours, service issues, etc.)

Most plant air systems have more than one compressor. If done right, controlling multiple units in concert generally increases both energy efficiency and pressure stability. Running multiple units independently often results in unstable pressure and wasted energy for several reasons:

- Running more machines than are necessary
- Running compressors at higher pressures than are needed
- Excessive idling or modulating

In addition to inefficiency and pressure swings as described above, an uncontrolled system increases the likelihood of increased maintenance requirements and costs due to excessive equipment cycling and motor starts.

Individual Compressor System Controls

The method by which a compressor matches its supply to the demand of the system is called capacity control. There are several different capacity control methods used in rotary compressors; modulation, online/offline, variable speed, and rotor length adjustment. In single compressor installations, some capacity control methods are better at handling part-load conditions than others. Many newer compressors can be switched from one capacity control method to another through their on-board controller. System control becomes more difficult when multiple compressors of varying capacity control methods are required to work together. We explore these options more in our FAQ section on controls.

CAGI is the leading organization representing manufacturers of compressed air system equipment, including air compressors, blowers, pneumatic tools, and air and drying and filtration equipment. This document is for information purposes and should not be used as a substitute for instructions from individual manufacturers. Always consult with individual manufacturers for specific instructions regarding their equipment.

CAGI, its members and participants in its activities, assume no responsibility, obligation or liability to anyone for any loss or damages in connection with the use, completeness, interpretation of, or reliance upon this document.

The most advanced types combine safe and efficient internal supervision of the machine with important maintenance-related information. In addition, newer controls may offer the ability to monitor and control compressed air equipment remotely via built-in web servers or connecting into existing plant monitoring systems via Ethernet or industrial bus options (DeviceNet, Profibus, etc).

Advanced Energy Management with System Master Controls

The more advanced the compressed air system master controller, the more it will optimize energy performance. Smarter controls can manage multiple compressors of different sizes and select the right mix of units to meet demand as it changes, while reducing energy consumption in three key ways:

Reduced compressor run and idling time – saving energy by operating only the units needed to satisfy demand, while reducing compressor starts and switching losses.

Improved pressure performance – recognize changes in air pressure quickly and accurately, thereby maintaining tighter pressure control. Eliminating “cascading” pressure controls with wide pressure bands can save another **10% in energy**.

Reduced “artificial” demand and leak losses – to compensate for potential leaks and pressure drop, many users set system air pressures higher than actually needed. This “artificial demand” results in a good deal of wasted cfm and energy. Advanced adaptive controls allow users to reduce the pressure while avoiding the risk of under pressurizing tools and equipment. Operating at lower pressure reduces both artificial demand and leak losses.

Master controllers take operational efficiencies a step further by controlling all compressors and accessory equipment in an air system installation together, and in relation to each other. Master controllers improve the pressure stability and reliability of a compressed air system by turning the individual compressor units on and off only when needed to meet a specified pressure. This greatly improves overall system specific performance (cfm/kW), and often helps balance compressor load hours for more effective maintenance scheduling. Newer system controls offer some or all of these advantages:

- Maintain system pressure within a narrow pressure band
- Monitor the rate of change of air pressure to determine the change in demand – and then calculate which compressor will best meet that demand
- Track the starting frequency of all compressors in the system so that they can be switched on or off quickly to minimize idle mode running
- Be programmable with the capacity and specific performance characteristics of each compressor
- Provide historical data to facilitate energy performance analysis

By using the correct combination of master controls and properly sized compressors, operators can effectively eliminate their concerns about part-load efficiency of fixed speed compressors. Compressors will either be running fully loaded or off on standby, and only one compressor, ideally the most energy efficient at part load, will be operating as the trim compressor.

Monitoring and Communication Capabilities

Modern compressed air system controls can also deliver communications capabilities that are hugely beneficial to plant operations personnel. The entire air system can be monitored, either as a standalone network or as part of a larger control system. In many cases, these controls allow access via Internet, giving the manager full access to their system virtually anytime and anywhere.

Remote monitoring also means that technicians can view system status and diagnostic codes prior to undertaking service activities. This capability makes troubleshooting easier, and typically reduces service or repair time as well.

Outbound alerting is another valuable functionality, providing the ability to automatically notify plant Operating personnel (or the plant's compressed air service provider) of problems or shutdowns.

Conclusion

An air system control unit is the quarterback of your compressed air system. It calls the plays, spots the dangers, and ensures everybody knows what to do. A control unit will often be your first alert when there is a problem so you can contain and fix the issue before it gets out of control. Having a great compressor without having a great controller is like an NFL team paying for a world class wide receiver...without having a great quarterback. Neither will be able to perform to their true ability.

A central controller can monitor, measure, and direct the optimal sequencing of the numerous components within a compressed air system to produce a dependable and efficient network. Many times, the inclusion of a central control system can reduce energy efficiency by 10 percent. Applications for mobile phones and tablets can also provide an additional level of real-time remote monitoring and control of one or many compressed air systems from almost any location.

Investing in a control system does not have to involve a large capital expenditure, but it should begin with a thorough analysis of your existing system by a trained, compressed air professional. If you are not sure what control systems your current equipment is following, call your manufacturer today.