



Energy Efficiency in Air Compressors

FACT SHEET

Compressed air is a versatile tool used widely throughout industry for a variety of purposes. Unfortunately, running air compressors (AC) often uses more energy than any other equipment.

Air compressor efficiency is the ratio of energy input to energy output. Many air compressors may be running at efficiencies as low as 10 percent. Improving AC efficiency can yield significant savings to your facility.

When talking about the efficiency of air compressors, it is important to remember that the compressor itself is only one part of the system; therefore, it is important to look at the whole system when discussing AC efficiency. Compressed air is the product of a system comprised of the air compressor followed by after-coolers, receivers, air dryers, air storage tanks, supply lines and possibly sequencers and multiple compressor units.

The total energy use of a compressor system depends on several factors. The air compressor type, model and size are important factors in the compressor's energy consumption, but the motor power rating, control mechanisms, system design, uses and maintenance are also fundamental in determining the energy consumption of a compressed air system.

CONTROL MECHANISMS

Match the controls. System controls are one of the most important elements of a compressed air system, and are also a central factor in air compressor system efficiency. Controls are designed to match the compressor output with the system demand. Controls may manage a single air compressor, or involve the orchestration of multiple air compressors to satisfy system needs.

Several types of system controls exist that may help to increase the efficiency of your system.

Single Unit Controls

- Start/stop – turns compressors on and off according to discharge pressure.
- Load/unload – leaves motor running continuously, but unloads compressor according to discharge pressure.
- Modulating – controls inlet volume to satisfy flow need.
- Multistep – for compressors designed to operate at multiple partially loaded conditions.

System Controls

- Sequencing – orchestrates compressors to meet demand by taking compressors off-line, or starting compressors to meet total system load.
- Network controls – orchestrates the controls for both individual compressors and the entire system.

SYSTEM DESIGN

Four aspects of system design are crucial to compressor efficiency.

Save for times of need. The first aspect involves choosing a receiver, or storage tank, to fit the needs of the system demand and prevent system pressure from dropping below minimum required pressure during times of peak demand. A drop in pressure will cause end tools to function improperly. The common response to the tool malfunction is to increase the system pressure. The energy used in increasing system pressure could have been saved through the use of a properly sized receiver.

Straighten the path. The second aspect of system design is the layout and design of the air delivery system. Narrow delivery lines, looping and sharp bends in the lines can create pressure drops in the system and reduce end use pressure. The common response to this is to increase compressor pressure and use more energy; this could have been avoided through better system design.

Use cooler intake air. A third design aspect that may have a significant impact on air compressor efficiency is the intake air temperature. The energy required to compress cool air is much less than that required to compress warmer air. Reducing the intake temperature by moving the compressor intake outside the building and into a shaded area may drastically lower the energy required for compression.

Single vs. multiple compressors. In some systems, it may be more efficient to use a series of smaller compressors rather than one larger compressor. Additional smaller compressors can be brought on-line, or shut down as needed.

Recover waste heat. Recovered waste heat can be used to preheat process and boiler water, for space heating, and more.

USES

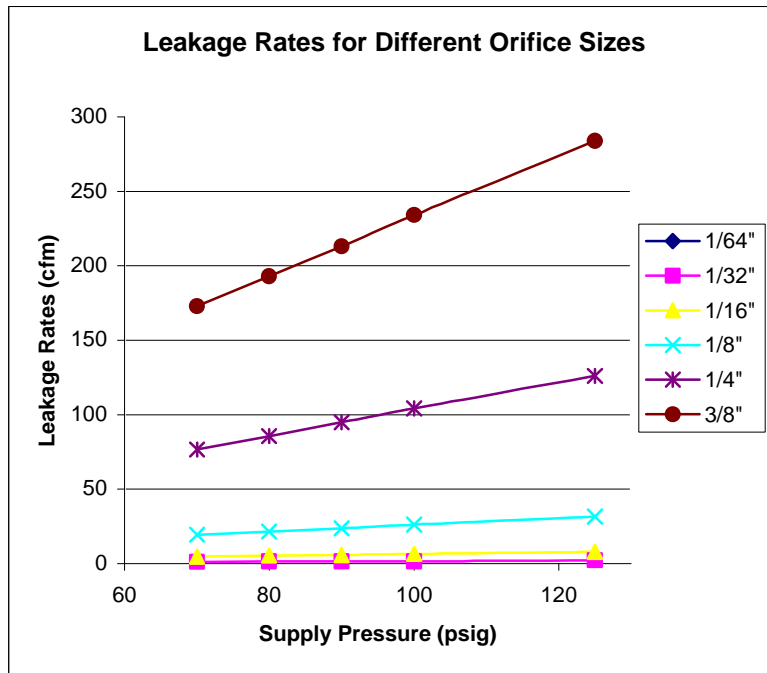
Discourage inappropriate uses. Because compressing air is one of the most expensive sources of mechanical energy in the industrial setting, it is often financially beneficial and more energy efficient to use alternative tools or methods when possible. Some common uses of compressed air that may be accomplished by other means are:

- Personal cooling;
- Cleaning where dry cleanup would be appropriate;
- Drying;
- Mixing, atomizing and aspirating;
- Process cooling; and
- Moving parts.

MAINTENANCE

Fix the leaks. This is the area where the most significant changes can occur. In addition to having a great impact on energy use, improvements here are also often relatively cheap and have immediate results.

The number one source of energy loss in an air compressor system can usually be traced to wasted air. Wasted air is lost through leaks in the system. Although leaks are often very small, significant amounts of air can be lost. The air lost is proportional to the size of the orifice and a function of the air compressor supply pressure. The following graph illustrates the amount of air lost through different orifice sizes.



Change the filters. Another important element of the system is filters. Filters are located throughout the system to ensure clean air for end uses. Often these filters are not known of or are simply not checked. Dust, dirt, moisture and grease can clog the filters leading to a pressure drop in the system. This pressure drop is not often seen for what it is and more compression energy is used to compensate for the clogged filters resulting in increased energy use.

RESOURCES

The Compressed Air Challenge - <http://www.knowpressure.org>

Department of Energy: Office of Industrial Technologies - http://www.oit.doe.gov/bestpractices/compressed_air



This is a publication of the N.C. Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance. Information contained in this publication is believed to be accurate and reliable. However, the application of this information is at the readers' risk. Mention of products, services or vendors in this publication does not constitute an endorsement by the State of North Carolina. Information contained in this publication may be cited freely.

DPPEA-FY03-31