High-Efficiency Industrial Compressed Air Systems
A Pacific Energy Center Factsheet

How This Technology Saves Energy

Compressed air systems are very common in industrial facilities. Air-powered devices are popular because they are reliable and compact. Unfortunately, compressed air systems are inherently inefficient, converting less than 10-20 percent of their energy input into usable compressed air. Consequently, reducing unnecessary compressed air usage and improving the efficiency of the compressed air systems themselves are excellent energy-saving strategies.

Efficiency Improvements

Find Alternatives to Using Compressed Air

Compressed air is often used because it is believed to be convenient, safe, and labor-saving. These advantages may justify the high cost of compressed air, but often more energy-efficient alternatives exist. Some are listed below.

- Use fans or blowers to dry parts, cool employees, or clean debris.
- Employ mechanical stirrers or low-pressure air for agitation, mixing, or aeration in non-explosive environments.
- Use a vacuum pump or system instead of special nozzles to create a vacuum.
- Brush or sweep, rather than blow away, dust and debris.
- Don't use pneumatic tools when electrical or hydraulic tools will work.

Reduce System Losses and Excessive Use

Air leaks, improper pressure regulation, and airflow restrictions can easily reduce a system's useful capacity by 50 percent or more. Typically, these problems are "solved" by adding a new compressor, when fixing the problem would be much more cost-effective and energy-efficient. Some possible fixes are listed below.

- Set up a leak reduction program to detect, monitor, and fix leaks in the air distribution system. A typical plant loses about 20 percent of compressed air to leaks. These are often found through visual inspections with soap suds sprayed on joints, or detectors that sense the inaudible hiss leaks make. A well-run reduction program can track leakage losses over time and determine when it is cost-effective to repair leaks.
- Use efficient pneumatic tools featuring efficient nozzles, squeeze-handles, shut-off valves, and timer controls. They use less air than inefficient tools to perform the same tasks. Automatic sensors are available that close off the air supply to work areas not in use.
Reduce air pressure losses by increasing the size of piping and accessories (such as air coolers, dryers, and filters), and eliminating piping turns. Each of these creates energy-wasting friction against the air moving through them. Specifying larger lines and equipment will not only save energy, but often improve system performance as well.

Improve system pressure control with valves to control air pressure, as well as larger air storage tanks. Many pneumatic tools operate at pressures lower than typical compressed air system pressures. Regulating valves can provide appropriate pressures, reducing the amount of air the tools consume. Lowering air pressures where feasible can reduce leakage as well as the load on the compressors. Larger air storage tanks can reduce peak compressor demand when the air load varies dramatically over time.

Improve Compressor Management and Control
Listed below are strategies for producing compressed air as efficiently as possible.

Manage multiple compressors efficiently in large industrial plants with multiple compressors. Advanced control systems can minimize the amount of time compressors operate under less-efficient part-load conditions. They also save energy by regulating pressure precisely, including lowering pressure when air demand is low.

Improve efficiency at partial loads by installing controls that adjust compressor air output with less waste. The efficiency of most compressors drops dramatically below 60-80 percent of full capacity. Depending on the type of compressor, better controls can increase its efficient operating range, or shut it down before it reaches the inefficient range. These controls can be ordered for a new compressor or retrofitted to an existing one.

Consider other improvements, such as installing controllers to vary compressor speeds, using outside air for intake when it is cooler than indoor air, and selecting high-efficiency equipment when adding or replacing compressor systems.

Recover Wasted Heat
Approximately 80-90 percent of the input energy to a compressor goes into raising the temperature of the compressed air. The water or air that removes this heat can be tapped for other uses, such as space heating; warming or drying materials; or preheating boiler, cleanup, or process water.

Benefits and Pitfalls

A wide range of measures exists to obtain energy savings from compressed air systems. In some situations, however, certain measures may not be feasible or economical. Both benefits and pitfalls of measures should be considered before selecting them.

Benefits

• Many efficiency improvements increase overall performance and reliability of the compressed air system, improving productivity and saving energy.
• Leak reduction programs increase useful compressed air capacity and mitigate pressure problems. Since leakage can account for 20 percent or more of plant air output, these programs generally pay for themselves within months.
• Reducing the operating pressure by 2 percent saves 1 percent of compressor energy in a typical 100 psi system.
• Measures that minimize the time a compressor must run, reduce system operating pressure, and/or reduce compressor cycling will improve the service life of a compressor. Measures to modify the size or layout of system piping, install oversized auxiliary equipment (such as coolers and filters), or replace major equipment are especially cost effective for new systems or plant expansions.

Pitfalls

• Most companies consider manufacturing productivity more critical than energy efficiency. They may be reluctant to make compressed air efficiency improvements that they perceive as reducing productivity.
• Possible energy savings can depend on compressor characteristics, such as its type and its efficiency at full and partial loads. For example, unloading controls may be impractical or uneconomical for reciprocating compressors, which generally perform better at partial loads than other types.
• In some cases, specific equipment might be incompatible with some of the improvements described. For example, some compressor manufacturers do not recommend using unloading controls on certain models.
• Relatively simple checks can be made to estimate the magnitude of leaks and pressure losses. Some of these tests, however, must be scheduled when production is shut down. This may not be feasible in some plants.
• For potential waste heat recovery applications, it is usually impractical to install long duct or pipe runs.
• Heat recovered from compressed air systems is relatively low in temperature, and has limited use. It can only be used as supplemental heat, since compressors do not operate all the time.

For More Information

Contact your PG&E representative or call 1-800-468-4743 for more information about PG&E’s energy efficiency programs and other services.

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