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Compressed Air System Leaks

The Cost, Common Culprits, Detection, and Repair

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Imagine leaving your doors and windows open during the coldest winter days. Your furnace would run nonstop to try and heat your house. Your energy bill would skyrocket. Your home would still be chilly, you'd scramble to find other ways to keep warm, and your furnace would wear out more quickly.

Now think of the equivalent scenario in a compressed air system. You should be thinking of the costs associated with compressed air leaks.

In this paper, we'll discuss how many companies are losing thousands of dollars each year to compressed air system leaks. We will address where leaks commonly occur, leak detection methods, and practical advice for an audit and repair plan. We'll explain why an ongoing leak detection and repair program can be one of the most cost-effective measures a company can use to benefit its bottom line.

The Cost of Compressed Air System Leaks

Compressed air systems are in nearly every industrial facility in the United States, and the undeniable fact about those systems is: they all have leaks. The U.S. Department of Energy, supported by countless system audits, estimates the average leakage rate is 25 percent. In fact, some plants lose as much as 80 percent of their compressed air to leaks. So, if compressed air systems account for an estimated $5 billion per year in energy costs, that equates to a large amount of energy needlessly wasted and millions (if not billions) of dollars spent on lost air. In addition to added energy consumption, leaks also cost compressed air users by impacting productivity and equipment life.

Let's take a closer look at how leaks can translate to large amounts of energy and money being wasted on a daily basis.

Wasted Electricity

Compressed air leaks are simply demands for air that create no value. Further, they consume flow needed by other productive uses. This often results in significantly decreased pressure at the points of use. To compensate, some users will then turn up the pressure at the compressor, which only makes things worse since a leak will waste more air at higher pressure. We can calculate the annual energy cost for each individual leak with the following formula:

> Annual cost of a leak = Leakage rate (cfm) x kW/cfm x operating hours x $/kWh

The following examples assume a typical compressor efficiency of 18 kW/100 cfm (0.18 kW/cfm), an electric rate of $0.10 per kWh, 100 psig, and nearly continuous operation:

- 1/16" leak at 100 psig: 6.5 cfm x .18 kW/cfm x 8,000 hours x $0.10 per kWh = $936 per year
- 1/8" leak at 100 psig: 26 cfm x .18 kW/cfm x 8,000 hours x $0.10 per kWh = $3,744 per year
- 1/4" leak at 100 psig: 104 cfm x .18 kW/cfm x 8,000 hours x $0.10 per kWh = $14,976 per year

Notes:

- The cfm flow through a leak varies with the air pressure and the size and shape of the orifice.
- Compressor efficiency for a particular compressor can be found on the CAGI data sheet for that model.

The average electrical cost per kW in the US is approximately $0.11/kW.

Again, the above examples are the cost per leak. It's easy to see how the total annual cost of all system leaks quickly adds up. In the real world example on the following page (Figure 1), a soft drink bottling plant had leaks that made up approximately half of the average compressed air consumption. With a local industrial electricity rate of $0.13/kWh, the constant demand cost as much as $34,000 per year in electricity. It is not unusual for estimated annual savings to range from $1,500 in smaller systems to $175,000 in larger systems.

Reduced Productivity

Excessive leaks can also cause system pressure to fluctuate, which can cause air-operated equipment to not perform as intended. High scrap rates and automatic equipment shutdown are common symptoms of this problem. A leaky system is also ill-prepared to take on additional capacity when surges in production and growth occur, since the system is already working harder than necessary to meet existing production demands.

Increased Service Costs

Maintaining pressure in a leaky compressed air system requires the compressor to run more. More run time means more frequent maintenance and possibly reduced equipment life. The more you have to repair a compressor, the more (often unscheduled) downtime that compressor will have, further reducing productivity. Ultimately, you may end up replacing the compressor sooner because it's continually working harder than necessary, thus reducing the overall service life of the system.

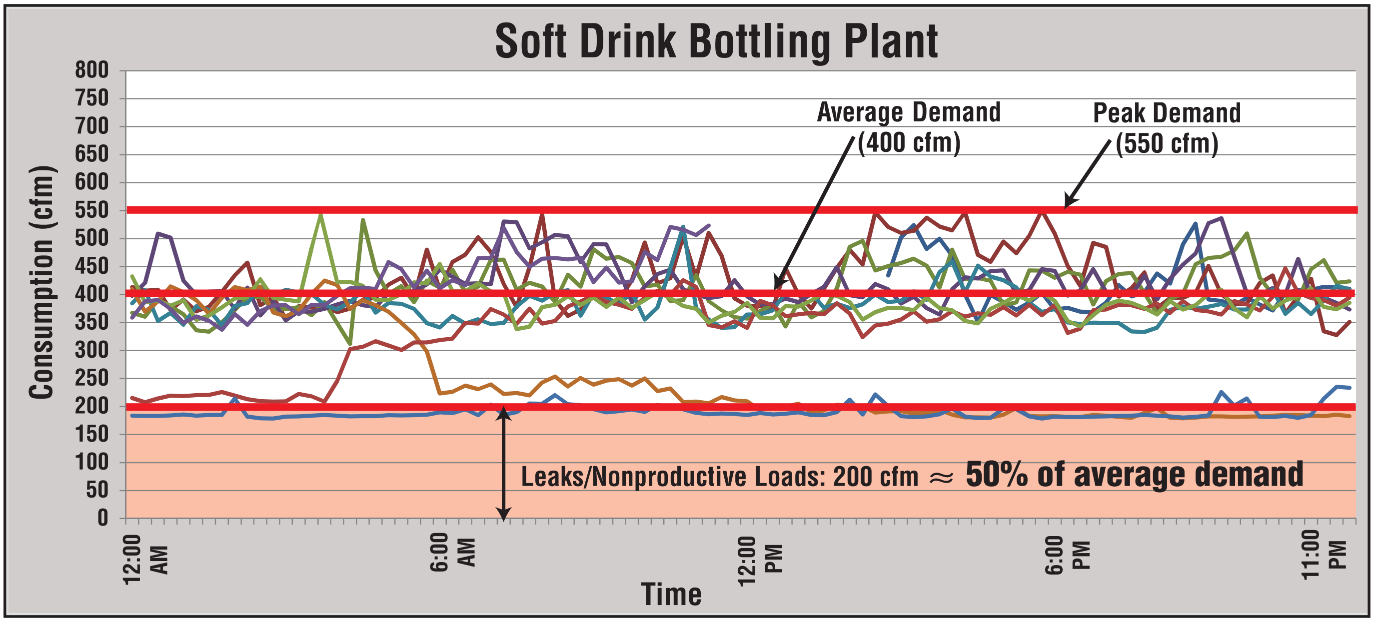

FIGURE 1: A soft drink bottling plant lost 200 cfm to leaks which resulted in $34,000/yr in wasted energy costs.

Common Culprits: The Dirty 30 and Other Frequent Problem Areas

Leaks are found from the compressor all the way to the points of use. The more fittings and hoses you have, the more leaks you are likely to have. They may occur in poorly installed fittings or in joints that have loosened or degraded over time. Leakage points are often located in what Tom Taranto, a well-known compressed air specialist, refers to as "the dirty 30" – the last 30 feet of piping to the point of use. This is generally the smallest piping and hose size, and gets the most vibration and stress from the point of use.

Problem areas include:

- Condensate traps
- Shut-off valves
- Fittings and pipe joints
- Filters, regulators, and lubricators
- Disconnects
- Hoses
- End-use equipment
- Bag houses
- Cylinder rod packing

Worn packing, missed welds, missing O-rings, and other issues can also be the source of costly leaks.

Leak Detection Methods

Too many users simply accept leaks as an unavoidable aspect of compressed air, just a cost of doing business. While it may not be practical to eliminate all leaks, it is not difficult to greatly reduce them. First, you must find them. There are three common methods of leak detection: listening and feeling, the soapy water technique, and ultrasonic leak detection.

Listen and Feel

A simple way to detect leaks is by listening for and then feeling leaks. This is only effective for large leaks that you can get close enough to touch. Plus you must be able to hear them above the noise of plant equipment. This technique will not work for most leaks.

Soapy Water

Another leak detection method is the soapy water method. Soapy water is applied with a brush to areas where a leak is suspected. If a leak is present, soap bubbles will form. Although reliable, it is time consuming, and requires direct physical access to the entire piping system. Leaks in overhead piping or in hard-to-access areas may not be detected. Further, this method does not provide information on the relative volume of each leak, leaving the user ill-informed about which leaks are wasting the most air.

Ultrasonic

The industry standard and best practice is to use ultrasonic leak detection. This is the most versatile form of leak detection and it can detect leaks as small as a pinhole. It's both fast and accurate. Plus, it does not require plant downtime to conduct a leak detection audit, because background noise does not interfere with its results. Unlike the first two methods, it can be done without physical contact with the leaks.

This method works because when compressed air is released into the atmosphere, the turbulence creates ultrasonic noise inaudible to the human ear but detectable with the right equipment. Ultrasonic leak detection equipment typically consists of directional microphones, amplifiers, and audio filters, and usually has either visual indicators or earphones to help the auditor identify the leaks. Figure 2 illustrates an example of ultrasonic leak detection equipment.

Since ultrasonic is a high frequency signal, the sound from a compressed air leak is both directional and localized to the source. This allows the ultrasonic detector to sense the leak in loud, noisy environments and locate the source of the leak. Some ultrasonic leak detection devices are also able to estimate and record the volume of leakage based on the decibel level of the leak.

FIGURE 2: Ultrasonic leak detection is versatile, fast, and accurate and it does not require plant downtime.

Expectations of an Ultrasonic Leak Audit

Once the leaks are found, a smart practice is to tag each leak with a bright, durable tag to make finding the leaks easy when it comes time for repairs. Information on each uniquely identified leak should then be documented on a spreadsheet or other document that allows you to calculate leak costs and prioritize follow-up action. Some vendors even offer spreadsheet tools with this capability.

Once the cost of each leak is determined, it should be easy to prioritize the most important leaks to fix first. A good leak detection audit should:

- Clearly identify each leak with an easily recognized tag that includes the date and a unique identifying code/number.
- Provide a list of leaks with their locations, unique identifier, and severity.
- Estimate the cost/potential savings of each leak and enable you to sort the list by leak severity.

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Report Prepared By:
Kaeser Sales Office

Detailed List of Compressed Air System Leaks
Prepared for: ACME Packaging

	Assumptions for Calculation						Cost and Energy Avoidance			
	Annual Operating Hours		Electricity Cost		Cost per 1000 cubic feet		Identified	cfm	kWh	CO_2
		8,760	$	0.10	$	0.33	$12,506.46	72	-	-
Tag Number	**Location Name**	**Pressure at Leak (psi)**	**dB Reading**	**Problem Description**	**Repaired (Y/N)**	**Work Order**	**Identified Leaks Cost Avoidance**	**Size of Leak (cfm)**	**Energy Avoidance (kWh)**	**CO_2 Avoidance (lb)**
935	Compressor Room 1	125	51	Leak at fitting			**$671.20**	3.9	N/A	N/A
936	Compressor Room 1	125	54	Leak at fitting			**$724.63**	4.2	N/A	N/A
937	Compressor Room 1	125	70	Leak at fitting			**$1,025.95**	5.9	N/A	N/A
938	Compressor Room 1	125	70	Quick Coupler Leak			**$1,025.95**	5.9	N/A	N/A
939	Compressor Room 1	125	60	Valve Leak			**$834.50**	4.8	N/A	N/A
940	Compressor Room 1	125	67	Quick Coupler Leak			**$967.47**	5.6	N/A	N/A
941	Compressor Room 1	125	65	Auto drain leaking			**$928.97**	5.4	N/A	N/A
942	Compressor Room 2	125	42	Quick Coupler Leak			**$517.46**	3.0	N/A	N/A
943	Compressor Room 2	125	42	Leak inside machine			**$517.46**	3.0	N/A	N/A
944	Compressor Room 2	125	68	Quick Coupler Leak			**$986.87**	5.7	N/A	N/A
945	Compressor Room 2	125	65	Quick Coupler Leak			**$928.97**	5.4	N/A	N/A
531	Compressor Room 2	125	30	Quick Coupler Leak			**$329.67**	1.9	N/A	N/A
532	Compressor Room 2	125	50	Blow Gun Leaking			**$653.63**	3.8	N/A	N/A
533	Compressor Room 2	125	62	Bad connection			**$871.98**	5.0	N/A	N/A
530	Compressor Room 2	125	55	Bad Valve			**$742.67**	4.3	N/A	N/A
514	Compressor Room 2	125	57	Bad Valve			**$779.07**	4.5	N/A	N/A

Fix the Leaks

The leak detection audit creates your action plan, but it is the repairs that will actually create the cost savings. This may seem obvious; however, all too often plants conduct or pay for a leak study and do little with it. Without the follow-up, the leak detection is just another cost. Your goal is to reduce total leakage to less than 10 percent of your total compressed air production. The good news is that the Pareto Principle (80–20 rule) applies: even just fixing the top 20 percent of the leaks can reduce the total compressed air leakage by 80 percent or more.

Start with the big leaks first. Repair main-system leaks during scheduled downtime. If an area can be bypassed during a repair, downtime isn't necessary.

Develop an Ongoing Program

It's important to recognize that leak detection and repair is an ongoing program. It will never be "one and done." As a system ages or is changed, new leaks can occur in areas throughout the system, or previously repaired leaks may need further attention. Having a leak detection audit performed every 6 to 12 months as part of your ongoing efforts will keep you focused on the biggest leaks. Work with whoever performs your leak detection audit to determine the best frequency of future audits for your plant. He or she can help you establish a program that continues to maximize plant productivity and profits through leak detection and repair.

Plant employees also play an important role in your leak detection and repair program. In many cases, even when the audit is contracted out, the repairs are assigned to plant staff. But even if an outside party handles the repairs, employees at all levels should be educated and encouraged to report leaks as they detect them. Oftentimes employees may be aware of leaks but do not realize the financial impact of the leaks. Overall profitability should be everyone's concern, so underscoring the benefits of eliminating leaks and dedicating resources to the task is critical.

Conclusion

Like a furnace heating a well-insulated home, a compressed air system with a minimum amount of leaks is more energy efficient and more effective. Leak reduction is one of the most cost-effective steps a plant can take to immediately reduce energy costs and improve profitability. Leak reduction also directly supports your company's goal to reduce its carbon footprint.

An ongoing leak detection audit and repair program will quickly pay for itself through energy savings (and may even be subsidized by local utility incentive programs). Equally important, you will likely see benefits from reduced downtime and better running production equipment. All of these contribute to a stronger bottom line.

About the Author

Matt McCorkle lives in Fredericksburg, VA where he works as the Manager of Branch Operations for Kaeser Compressors. He holds a Bachelor's degree in Mechanical Engineering from the US Air Force Academy and a Master's of Engineering in Industrial and Systems Engineering from the University of Florida. Matt has worked as a licensed Professional Engineer and has been a certified energy manager through the Association of Energy Engineers. He was instrumental in establishing Kaeser's nationwide leak auditing program.

Technology Meets Tradition

Our compressed air heritage is built on a century of manufacturing experience. Generations of quality craftsmanship guide our engineering principles of efficiency, reliability, and serviceability.

This tradition of excellence also drives new technology development. Advances in airend design, controls, and system design ensure our customers can meet the daily challenges of their manufacturing operations.

Each Kaeser product is designed with the future in mind, but we never lose sight of our roots. Technology needs may change from year to year, but the need for quality and reliability will always remain.

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