Thermal Gas Mass Flow Meters in Industrial Compressed Air Monitoring Systems Identify Costly Leaks

A Technical White Paper

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Flow meters are used in a wide variety of industrial applications. Many of these applications have requirements that are dictated by environmental and regulatory requirements. Others are purely based on a company's need to improve plant and process efficiencies to save money or lower costs. Of these two categories, the first requires you to "just do what the rules say" and the second is a proactive stance because "it just makes good economic sense". For those industries in the latter category, there is probably no more compelling an economic case for installing a thermal mass flow meter than for monitoring compressed air systems.

Payback

A thermal mass flow meter can be installed to monitor for normal baseline usage, then spikes or increases in usage that are likely caused by air leaks can be easily identified. The payback period for implementing such a compressed air monitoring system is usually measured in weeks - rather than years. In fact, most plant managers don't realize that it isn't always necessary to make a major capital investment to reap an almost immediate return. Identifying and repairing leaks in compressed air systems usually provides a very fast, and dramatic return. Incorrect staging of compressors is another factor that drives up operational costs since compressors run best at full capacity. VFD's don't always solve motor issues and staging a compressor uses @70% of the power load capacity even if the compressor is cycling or at running less than full capacity. In the case of one Kentucky-based cement plant, the estimated energy savings, plus the gains from lower compressor maintenance, and turning off expensive motors was in the range of $440,000 annually. And this was just one plant.

Compressed Air Isn't Free

The problem is that many plant personnel don't quite understand that there is a cost associated with compressed air usage. In fact, it is an expensive utility in most cases. In 1995, the Department of Energy (DOE) instituted the "Compressed Air Challenge". The goal was to help industry reduce usage by 10% by 2010. The DOE pointed out that compressed air is one of the costliest plant utilities - and that 30% of all compressed air produced in the US is lost to leaks. At the conclusion of the study, the DOE estimated the annual loss to be around $3.2 billion.

Q: Why is Compressed Air so Costly?

A: It is both expensive to produce and inefficient to use. The annual operating costs of an electric motor is $200, whereas a compressed air motor is $1,500. Furthermore, of the initial energy required to produce compressed air, less than 20% will be left for performing useful work. Think about it: 80% of the total energy required is gone even before any air enters the distribution system.

Wasteful Habits

While design and compressor efficiency are important factors to consider regarding system efficiencies, there are two other major factors: misuse and leaks. Many plant personnel, working under the assumption that "air is free", often waste and misuse it. Air leaks are often ignored. It is not uncommon to walk through a plant where the telltale "hissing sound" associated with air leaks is considered "background noise". Engineers may misunderstand the inefficiency and cost associated with compressed air. Common wasteful practices include using compressed air to cool bearings or to continuously blow on conveyors to clean them.

Aging Systems

Leaks can be found in virtually every plant's compressed air system. Worn out piping, poor maintenance, wrong hoses/connections are just some of the major causes for costly leaks. The question is this: just how severe will the losses be? Many companies report annual losses in the hundreds of thousands of dollars. The chart below is an example of how costly these leaks can be. While these numbers relate to one leak, imagine the cost of multiple leaks in a given system. Since about 30% of all compressed air is lost to leaks, reducing this figure will likely be the single most important energy saving activity any factory can undertake. A recent EU study showed that minimizing air leaks far surpassed other technologies like installing variable speed drives or waste heat exchangers in terms of the overall impact on energy savings.

Air Leak Cost

Leak DIA	Air Loss CFM	CFM Loss/day	$Loss/day	$Loss/year
1/32	1.60	2,304	$0.51	$186.00
1/16	6.45	9,288	$2.04	$744.00
1/8	25.80	37,152	$8.17	$2,981.00
1/4	103.20	148,608	$32.68	$11,928.00
3/8	234.00	336,960	$74.13	$27,036.00

Note: Based on 100psi, $0.22/MCF, 8760 hours/year
Source: Department of Energy

Fox Flow Meters Monitor System Usage

Your first step towards reducing costs is to install thermal mass flow meters on each compressor (usually done upon commissioning). The flow data captured by thermal mass flow meters provide an indication of where savings are possible at the department level - and how much is possible across the entire plant. They do this by providing an overall baseline of compressed air usage for a given level of factory activity. Any deviation from this baseline - without a corresponding change in activity - would tend to suggest a system leak. After leaks are identified and repaired, a new baseline can then be determined. One plant manager in an Indiana bottling plant reported an immediate payback on his thermal meters when they helped him identify air flow in pipes leading to a decommissioned section of his plant. "After installing the flow meters, we discovered a

substantial variation in the readings on particular lines and overall air consumption. The source of the anomaly was quickly identified /corrected, resulting in significant energy savings." Compressed air leaks can also cause a drop in overall system pressure. This can cause equipment to cycle more frequently, increasing maintenance costs and factory downtime. Using flow meters to monitor multiple lines helps operators optimize loading.

The Next Step

Getting a handle on waste can also be remedied with a survey - and the technology of choice is a portable ultrasonic detector (http://en.wikipedia.org/wiki/Gas_leak_detection # Ultrasonic Detectors). These instruments pick-up the high frequency sound produced by air leaking under pressure. Directional in nature, ultrasound makes it relatively easy to locate the leak source. Later, the survey report should list all identifiable leaks by location. It should also contain the reporting tools to calculate and demonstrate the potential cost savings from repairing these leaks.

Bottom Line

Mass flow measurement, combined with ultrasonic leak detection, is required to implement an ongoing leak and efficiency management program. As a solutions integrator, we bring the mass flow expertise to the table and solve the issues within your compressed air system. We also recommend you should identify individuals with the ultrasound expertise in your area to partner with to pinpoint costly leaks. Teaming up with those in your area should be mutually beneficial.