CASE STUDY

K&I Instruments Metering Case Study **May 2020**

How a 90-Day Trial Led to 26-Metering Solutions

Whether it's measuring compressed air on the output of a compressor, combustion air to a burner, or to measure air feeding the kiln for clinker burning, thermal mass flow meters provide cost-efficient and accurate measurement solutions.

COMPRESSOR ROOM

The compressor room is an essential component for transportation of compressed air within the utility system. The number of compressors in a system will vary depending on the conditions and load. Since plant air pressure is generally 6-7 times higher than the air we breathe, dryers (desiccant or refrigerant) help to remove moisture from the system. A good compressed air system has receiver tanks and valves strategically located throughout the plant, storing a specific volume of compressed air based on the demand, then controls the air to flow through the pipe as needed towards the final destination. Additionally, Variable Frequency Drives (VFD's) also peak performance when applied correctly to balance loads.

Over 13-years ago I visited with an existing client and offered them the ability to monitor the efficiency of their compressed air system by monitoring one of their four Ingersoll Rand 42" Piston-driven XLE Air Compressors (shown in figure 1). As usual, Plant Engineers and Maintenance Supervisors aren't fond of sticking their neck out on a line to try a new product or service. The Cement Plant in question has a supervisor who shared with reserved skepticism, "I would be willing to try your air metering solution only if you offer me 90-Day terms and if doesn't work I have the right to return the product". Confident that my solution would work, we went forward with the proposed $3599 solution for a 90-Day trial and evaluation.

Figure 1: Ingersoll Rand Model XLE 500 hP Air Compressor.

Two-weeks into the Trial

Darrell, the supervisor in charge of the 90-Day T&E called me up after two-weeks into the trial stating, “Come get your flowmeter, I think it has a bad capacitor that is bleeding off, the meter is only reading half of what it should be reading”. For those unfamiliar with thermal dispersion technology, it’s been around since 1917, however it wasn’t a proven technology for use in industrial gas applications until the mid-1970’s when two PhD Engineers from Stanford started applying the theory for a variety of gas measurement applications. In this application, thermal mass flow meters are ideal for measuring the compressed air flow outlet as the devices measure mass flow and do not require the added expense of pressure or temperature sensors, as well as a flow computer to determine flow correction.

Back to Darrell and his new problem. At the time, I had 15-years of experience helping clients on improving energy efficiencies. The Fox Thermal FT2 flow meter (in Figure 2) was easy to install and has no moving parts in the gas/air stream. When I responded to Darrell, I told him “Would you mind if we take a look at the meter in service before we pull it out?” As we walked the ¼ mile up to the compressor room with Charlie, his instrument tech, we heard the air compressors running.

Figure 2: Fox FT2 air flowmeter on an application for a waste treatment plant in 2005.

Two Huge Problems

Running Air Compressors are seldom seen as a problem. However, in this particular case, the Cement Plant was in blackout condition, only water and lights should have been running that day. Darrell looked at Charlie and stated, “Charlie, why are the air compressors running, we are in blackout?” When we walked up to the VFD’s controlling the compressors, we uncovered the second huge problem, #1 Compressor was running at 50% load (1160 SCFM), #2 Compressor was running at 50% load (1160 SCFM), with a trim compressor running at 10% load (260 SCFM). That is THREE, I repeat, THREE air compressors running in blackout, making 2580 SCFM for leaks within a 10,000 SCFM system. Having worked with the local Ingersoll Rand distributor back in the late 80’s while in college I was taught two valuable lessons about air systems…1) Air Compressors run best at full load and 2) Air Compressors use 70% Amp draw on their compressor motors just to cycle properly without putting one cubic foot of air into the system.

I looked at Darrell and shared, “You have a secondary problem, compressors run best at full load, you are pulling 40 Amps on #1, 40 Amps on #2 and 35 Amps on #3. You need to shut off two compressors and run One at full load (52 Amps) to make the air necessary for leaks in blackout.” Think about it, 26% of their system air for leaks and an additional 63 Amps of continuous power draw for incorrectly staging their air compressors. What initially appeared to be a faulty Fox Thermal flowmeter ended up with the flowmeter reading accurately, but more importantly diagnosing two huge problems. Darrell looked at me and said, “We need to get 3-more compressed air flowmeters to monitor all four-air Compressors, how quickly can we get them?”

A Simple Math Formula for Success

When calculating a return on investment (ROI) it’s one thing to look for small leaks in an air system, all systems leak. But, it’s an entirely different beast when dealing with air system mismanagement.

Now let’s looks at the air system mismanagement issue #1:

Total Air Leaks during Blackout: *2580 SCFM (Compressor #1, 50% load, 1160 scfm, #2, 50% load, 1160 scfm, #3, 10% load, 260 scfm)*

Formula for Cost: ***(****Voltage X 1.732 (3-phase motors) X Amperage X Power Factor X Hours X days****)***

(4160 V X 1.732 X 40 A X .85 PF X 24 X 30.5) ***=179321*** *kW hrs/month #1*

(4160 V X 1.732 X 40 A X 1 PF X 24 X 30.5) ***=210966*** *kW hrs/month #2*

(4160 V X 1.732 X 35 A X 1 PF X 24 X 30.5) ***=184595*** *kW hrs/month #3*

574882 *kW hrs X 0.04*

Air Leaks = Total Cost $22995/month

Now let's looks at the air system mismanagement issue #2:

Incorrect Staging: *115 Amps continuous power draw* ***=115 Amps***
Compressor #1 Full Load (2580 SCFM 100% load) ***= -52 Amps***

Lost Power with Compressors #2 (50%) and #3 (10%) ***= 63 Amps***

Formula for Cost:

(4160 V X 1.732 X 63 A X 1 PF X 24 X 30.5) ***= 332271*** *kW hrs month (#2 & #3)*

(274256 kW hr – 233117 kW hr) = ***41139*** *kW hrs month (Eff. Diff #1)*

373410 *kW hrs X 0.04* ***=***

Incorrect Staging = Total Cost $14936/month

Total Cost of Inefficiencies = $37931/month *or*

$455172/year

Re-allocating the Air Source

The Cement plant in question had such great success in identifying compressed air leaks that they shifted from maintaining their own compressors (the 4-XLE Ingersoll Rand units from the late 1970's) to now renting the air offsite and allowing the vendor to supply the plant air similar to the setup on page 1 of this application guide. Initially, what the plant had planned to upgrade their compressed air system led to a total plant-wide re-allocation of compressed air and fan air as well as how they maintained their air systems. They even took the existing four meters used on compressed air, had them recalibrated for natural gas and re-allocated them for their burners to optimize the efficiency on the fuel-air mixtures.

Figure 3: The Cement plant clinker burning is produced inside the kiln during the cement manufacturing process.

Use of TDF in Clinker Production

Cement and clinker are not the same material. Cement is a binding material used in construction whereas clinker is primarily used to produce cement. This plant was looking to use TDF (tire derived fuel) as a supplemental fuel for their clinker burning process. Increasing the TDF usage for the clinker system substantially reduced fuel costs. To accomplish this feat,

Figure 4: The Clinker burning process using TDF.

the engineers started looking for a way to optimize their kiln by measuring the air flow across the kiln in twelve strategic locations. What initially started with the Fox Thermal FT2 air flowmeter led to an upgrade in technology, using the newer FT1 with a DDC sensor, capable of both validating calibration in the field as well as configuring the meter for the parameters on-site with the GAS-SelectX feature. The results for the project proved extremely valuable in optimizing the efficiency of the kiln.

Conclusions

Air leaks combined with mismanagement of an air system will lead to major waste of perhaps the most expensive utility in a plant, air. To combat these issues, air flowmeters will not only provide baseline information of usage to help determine the efficiency of each air compressor, air flowmeters will also help to identify system mismanagement on fans feeding air to the burners and the kiln. Whether it be VFD's, dryers, I.D. fans, directional control valves or receiver tanks within the air system, it's critical to continuously monitor your air system. One trial may not always lead to 26-applications with air flow solutions, but you will never fully comprehend the true value of air metering until you look at the bigger picture from a plantwide perspective.

- When designing new plants or retrofitting old ones, be sure to consider compressed air requirements. Implementing compressed air flowmeters in several key areas offers a wide range of benefits: higher capacity, improved quality, lower energy costs, reduced maintenance, and increased life.

- Consider the benefits of using VFD's in an alternating mode to maximize compressed air systems as well as balancing air flows across the kiln. One of the most common air problems is incorrectly staging air compressors at less than full capacity, which frequently results in unnecessary cycling, or pushing capital equipment to the limits. Inserting a flowmeter frequently eliminates these problems.

- Another key safeguard is to protect your capital equipment from accidental mismanaged conditions, which can lead to expensive repairs on compressors or fans. Inserting an air flow meter in your process loop not only protects the equipment from damage, but will alert you to a potential problem and let you be proactive in evaluating upset conditions. Fox Thermal mass flowmeters are uniquely suited for these applications.

FT1 In-line

FT1 Insertion

FT1 Insertion Retractor

The Model FT1 has been designed to fit the most common applications for Thermal Mass Gas Flowmeters. It is equipped with the 2ndGeneration DDC-Sensor™, the Gas-SelectX™ gas menu, and the Zero CAL-CHECK™ Calibration Validation test. This meter is accurate, reliable, and available with a very short lead time. The Model FT1 measures process gas flow and temperature for a variety of Industrial Gas, Air and Wastewater applications.

FT4X In-line

FT4X Insertion

FT4X Insertion Retractor

The Model FT4X has been designed to fit the most rugged Oil & Gas applications for Thermal Mass Gas Flowmeters. It is equipped with the 2ndGeneration DDC-Sensor, the Gas-SelectX gas menu, and the CAL-V calibration validation test. This meter is available with remote display, meets API 14.10 and BLM 3175 compliance, and available with a very short lead time. The Model FT4X measures process gas flow and temperature and is perfect for Flare, Vent, Sale and Fuel Gas applications.