Measuring and Monitoring Compressed Dry Air Systems (CDA)

In most industrial facilities Compressed Dry Air (CDA) is a primary component of overall energy use. In fact, compressed air is considered to be the “fourth utility” after electricity, natural gas and water, and its cost is very often higher than the other three when compared by cost per delivered unit of energy. As the costs of energy continues to rise, accurately tracking the use of compressed air with Master-Touch™ flow meters can provide direct and immediate benefits by giving you the information you need to establish a program that:

- monitors general usage to encourage energy and plant cost conservation;
- tracks peak usage to correctly determine optimum compressor capacity; and
- simplifies your overall gas measurement instrumentation needs through the use of thermal gas mass flow technology.

For many years compressed air was most commonly measured by differential pressure orifice plate flow meters. Unfortunately, their very method of measurement — the plate pressure differential — creates a significant pressure drop in the system. Due to the square function characteristics of the pressure drop, the meters typically have a very limited turndown of approximately 5:1, making them unsuitable for monitoring system leaks or even off-peak usage. And if mass flow rate outputs are required, manual or computer calculations incorporating physical process measurements such as absolute pressure, differential pressure, temperature, and viscosity readings must be applied to the output signal to obtain the correct flow rate. Pressure drop, limited turndown and complexity are the necessary evils of using orifice plates to measure the flow rate of compressed air. The introduction of thermal mass flow meters addresses these inherent problems.

Determining the true demand in a compressed air system, whether for a new installation or for an upgrade, can be a difficult task but it is critical first step in any design. Once operational, the demands upon a system will typically fluctuate significantly. In either case, the most accurate method of monitoring the system is through the use of one or more flow meters installed at strategic locations in the facility served by the system.

Potential points of measurement in a compressed air system are:
A Intake air;
B Total usage;
C Distribution pipes; and
D Work areas.
**Thermal Technology**

Constant temperature thermal mass flow meters, such as those produced by EPI, operate on the principle of thermal dispersion or heat loss from a heated Resistance Temperature Detector (RTD) to the flowing gas. Two active RTD sensors are operated in a balanced state. One acts as a temperature sensor reference; the other is the active heated sensor. Heat loss to the flowing fluid tends to unbalance the heated flow sensor and it is forced back into balance by the electronics. The effects of variations in density are virtually eliminated by molecular heat transfer and sensor temperature corrections. Therefore, thermal mass flow meters are now the preferred choice for use in compressed air systems.

**Specifying the Requirements**

A number of factors must be considered when selecting and specifying any instrumentation and this is true for thermal mass flow meters to be used in compressed air systems. To specify the best configuration, you must determine:

**What are the flow measurement conditions**, such as the minimum and maximum flow rates* to be measured, the process pipe size, the air temperature and line pressure? These parameters will determine the calibration scale and the expected accuracy, as well as help to identify potential issues with the overall installation.

*These values are often expressed as CFM (cubic feet/minute) so it is important to understand the differences between SCFM (Standard cubic feet/minute), ICFM (Inlet cubic feet/minute) and ACFM (Actual cubic feet/minute) for compressed air systems:

- **Standard units** of measurement are referenced to a well-defined temperature and pressure which establishes the mass of air per volume. 70°F and 14.7 PSIA are commonly used for compressed air, though other specific values are often used, too.
- **Inlet units** of measurement are determined by the air temperature and pressure at the intake of the compressor system. These units are typically very close to the Standard units.
- **Actual units** of measurements are the most variable because air is compressed or expanded by its pressure and temperature. For example, if we assume a constant temperature, then one ACFM of air at 29 PSIA has twice the mass of one SCFM at 14.7 PSIA.

**Where will the flow meter be installed** and what is the piping configuration upstream and downstream of that location? The flow readings will be most accurate where the air flow profile in the pipe is uniform and consistent so that the sensor output at the point of measurement is truly representative of the overall flow through the pipe. All instrument manufacturers’ recommended straight run requirements are offered to help end-users determine suitable locations for the flow meters, but it is important to recognize that these are only guidelines and not guarantees of optimal positioning.

**Is there moisture present at the point of measurement?** Most compressors will produce water droplets entrained in the air flow as a result of the compression process. Simply stated, thermal mass flow meters will not read accurately if water droplets come into contact with the sensor RTDs, so installing the flow meter at a location where the air is dry is strongly advised.

Master-Touch™ thermal flow meters provide real-time mass flow measurement and totalization for continuous CDA flow monitoring. A variety of sizes and configuration are available to meet virtually any installation requirement. One very common strategy is to use insertion style flow meters with ball valve assemblies that hold the flow meter firmly in place and yet allow the flow meter to be removed and reinstalled as necessary while preserving the air line’s integrity. If the survey of a compressed dry air system rotates from line to line throughout a large system, multiple ball valve assemblies can be installed at all points of measurement. Then, flow meters can be installed in the desired locations for the duration of the survey and moved on to new locations for the next series of measurements. In this way, a very large system can be monitored efficiently and economically.