

APPLICATION BRIEF

Sage Metering Application Brief

June 2016

Air Flow Meter for Industrial Applications

There are many reasons to measure air flow. This technical note explores the use of air flow meters to measure combustion air to boiler fuel (to assure the proper ratio of fuel to air), as well as monitoring the compressed air in various industries and processes. Both applications improve the efficiency of the process and reduce costs.

All About Air

Air is the most common gas on Earth and supports life. Dry air consists of nitrogen (78%), oxygen (21%), argon (~1%) and trace amounts of carbon dioxide, methane, hydrogen, helium, and neon. Additional gases that are considered pollutants may also be present in the parts per million range, such as sulfur dioxide, nitric oxide, and carbon monoxide.

The water content of air will vary depending on the region ranging from 1% to 4% in hot and high humidity areas.

The density of dry air at standard conditions for temperature and pressure (STP) (70° F and 14.7 psi) is 0.0749 lb./ft³. The density will vary based on the temperature and pressure, for example at 90°F and an elevation of 5000 feet, with a pressure of 12.2 psig, the density of the air is 0.060 lb./ft³. Compressing the air, however, to 100 psig at 70° increases the density to 0.58 lb./ft³. The density of air at different pressures and temperatures can be calculated using the ideal gas law.

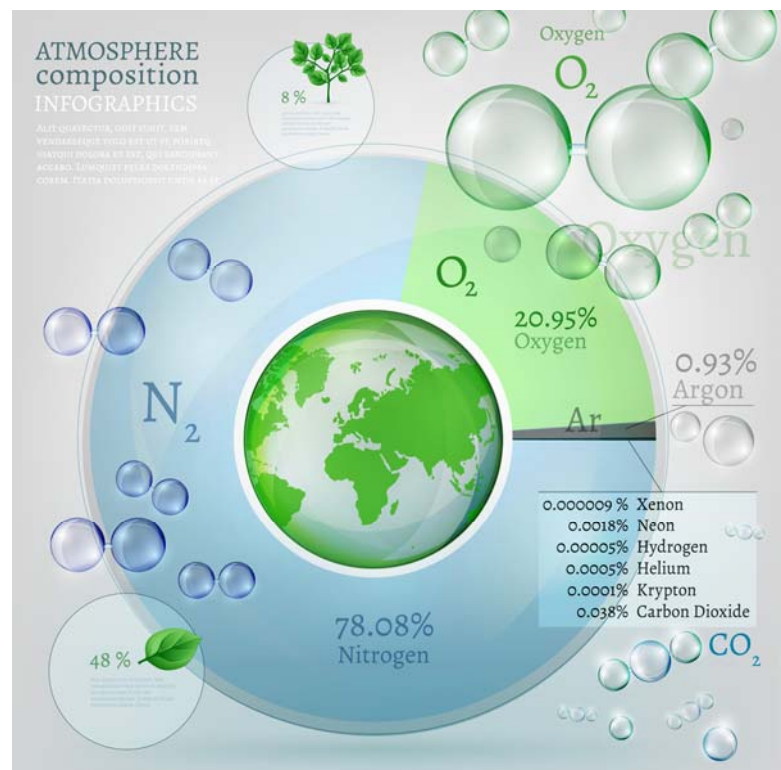
While most air flow meters measure the flow rate at the actual conditions where the measurement is being made, the general practice is to relate the flow rate to STP conditions. This requires knowing the air's pressure and temperature at the measurement point. Flow measurements at STP conditions are mass flow since they are referenced to specific operating conditions.

Flow Rate or Total Flow?

There are two ways of measuring and reporting flow. In one case, the flow is indicated by the **total flow** since the previous reading. In this case, the measurements can be in units of SCF (standard cubic feet), pounds, kilograms, or normal cubic meters. More often, however, the **flow rate** over a specific time is desired, such as SCFM (standard cubic feet per minute) or pounds per hour.

Combustion Air Flow

Combustion is the burning of air and fuel. The most efficient combustion occurs with an optimum amount of each. This is referred to as air–fuel ratio and is the mass ratio of air to fuel present. If there is too little air, incomplete combustion occurs which results in lower combustion efficiency plus emitting unburnt fuel to the atmosphere. Alternatively, too much air flow means that the excess heated air is emitted to the atmosphere. Thus, there is a waste of energy. For more information on combustion efficiency see the Sage white paper, "[Combustion Efficiency and Thermal Mass Flow Meters](http://goo.gl/yG6tnD)," at <http://goo.gl/yG6tnD>.



Compressed Air Flow

Measuring the compressed air flow rate in industrial facilities can help determine when and where compressed air is used. This can assist in identifying wastage thus improves operational efficiency. If there are multiple air compressors, knowing the flow rate from each can help optimize the distribution of compressed air and/or assist in determining the compressors efficiencies. Optimization of the compressed air flow may defer acquiring a new compressor. Additionally, the air flow measurements can help size new compressors when it is appropriate to purchase. Air flow measurements may also determine if it is acceptable to shut down a compressor during periods of reduced air flow requirements. Due to the low flow sensitivity of thermal mass flow meters, they can be used for leak detection if the compressed air demand is turned off. More information on using thermal mass flow meters to determine compressed air flow is in Sage Metering's "[ISO 50001 Energy Management](#)" white paper, at <http://goo.gl/zHnPAf>.

Methods to Measure Air Flow

Different types of instruments measure the air flow. These include differential pressure flow meters (orifice, venturi, averaging Pitot tubes), vortex shedding flow meters, turbine flow meters, and positive displacement meters. All of these instruments measure the air flow at the actual conditions and require the measurement of pressure and temperature to obtain mass flow at STP condition.



An advantage of the thermal mass flow meters is that they do not require additional pressure and temperature measurement because the meter measures the mass flow of the air referenced to STP conditions. Thermal mass flow meters can also handle large compressed air pipes even if they are heated. Additionally, thermal mass flow meters offer extremely high rangeability, the insertion probe is very easy to install in a pipe or duct, can measure very low flow rates, they do not create any pressure drop and are the most cost-efficient flow meter to obtain mass flow. For more information on this meter type see the Sage white paper, "[Fundamentals of Thermal Mass Flow Measurement](#)" at <http://goo.gl/UQt6V5>.

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Related Applications

- Building exhaust air flow to ensure proper ventilation
- Cooling air flow to a heat generating device to prevent damage
- Wastewater aeration air flow

Considerations for Flow Meter Selection

- Mass flow measurement without the need for temperature and pressure devices
- Easy to install an insertion probe directly in the pipe
- Probe retraction assembly permits removal or insertion of probe in pressurized pipes
- High rangeability
- Creates minimal pressure drop
- Excellent reliability provides long-term maintenance-free operation



Sage Prime Pictured

Recommended

- Sage Prime
 - Integral style
 - Remote style
- Sage *INSIGHT*
 - Software for validation ease