An Inside Look at Gas Mixers

by Dennis M. Richardson

Gas mixers are widely used to mix gases on-site from a bulk source. Although gas mixers have been utilized since at least the 1950s, their usage is increasingly common due to advances in gas mixing technology and the inherent labor savings gained when using gas mixers versus premixed cylinders. The term "gas mixer" used in this article is synonymous with the term "gas blender" and "gas proportioner."

Applications

The applications for gas mixers fall into these major categories:

- Shield Gases for Welding
- Atmospheres for Heat Treating
- Modified Atmosphere Packaging for Food
- Special Applications

The largest application for gas mixers is shield gases for welding. Typical two gas mixtures for welding are CO_2/Ar, O_2/Ar, and He/Ar. Three gas mixtures for welding shield gas are also common such as CO_2/O_2/Ar and CO_2/He/Ar. Gas mixers may be used for only a few welding stations as well as installations with hundreds of stations. Correspondingly, flowrate capacities range from about 200 SCFH to greater than 30,000 SCFH. Shield gas mixers come in a wide variety of configurations, including gas mixers intended for outdoor service, integral gas analyzer, and high accuracy designs.

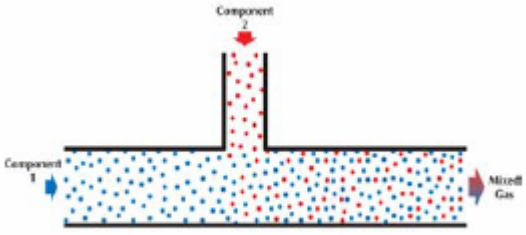
Gas mixers for heat treating applications generally mix H_2/N_2 as a furnace atmosphere. It is important that these gas mixers meet the NFPA standard pertaining to furnace atmospheres, NFPA 86c. This standard requires that a gas analyzer be used to monitor the gas mixture for safety reasons.

Gas mixers such as CO_2/N_2 are commonly used to package a wide variety of foods, including meat, baked goods, and cheese. Other mixtures are also used, such as CO_2/O_2 and $CO_2/O_2/N_2$. The gas mixing system must be designed so that it does not introduce any contamination into the food, and a gas analyzer is also a good idea to prove that the packaging process is receiving the correct mixture.

A number of other applications are suitable for on-site gas mixing, including air bag manufacture, blanketing of chemicals, laser assist gas, window pane filling, light bulb filling and blanketing of molten metals. Gas mixers for these applications are usually customized per the application.

Gas Mixing Basics

Gas mixers inherently produce a gas mixture which is more homogeneous than gas mixtures created in cylinders. When gases are mixed in a gas mixer, the flowing gases are combined under turbulent flow conditions, usually an arrangement where the gases meet at right angles. This arrangement produces a very homogeneous mixture.



Turbulent Flow Gas Mixing Tee

Producing gas mixtures in cylinders is normally accomplished by successively adding one component after another to the cylinder. This procedure produces layers of gases in the cylinder. After filling, the gases in the cylinder can be mixed by rolling the cylinder, or natural mixing between the gas layers will occur after some period of time, normally a matter of days or weeks. Use of a dip or distributor tube in the cylinder will dramatically improve mixing in the cylinder.

Gas Mixer Designs

In the industrial gas business three design types of gas mixers are typically utilized: Constant Flow, Surge Tank, and Surge Tank with Gas Analyzer.

Constant Flow Gas Mixers

Constant flow gas mixers continuously flow during gas mixing demand, in contrast to surge tank type gas mixers which alternately flow gases into a surge tank. Constant flow style gas mixers employ schemes that keep a consistent pressure drop across flow restrictions over a wide range of flowrates. These types of gas mixers have a minimum flow requirement in order to maintain accurate gas mixing.

Surge Tank Gas Mixers

Surge tank style gas mixers operate with a surge tank, solenoid valve, and pressure switch. When mixed gas demand depletes the surge tank to a lower pressure, the

pressure switch actuates a solenoid valve, allowing the mixed gases to flow into the surge tank until the upper pressure is achieved. Each of the inlet gas streams are regulated to the same pressure with their respective regulator; typically a fixed orifice is downstream of the major gas regulator and a metering valve is downstream of the minor gas regulator(s). Once the proportion is determined by adjusting the metering valve(s), the proportion stays the same regardless of the mixed gas demand; only the frequency of the cycling action changes. It is worth noting that the gas mixing is complete in the piping before the mixture reaches the surge tank.

Surge tank gas mixers are usually more expensive than constant flow type gas mixers, but have the significant advantage of maintaining an accurate proportion down to zero flow. Consider the example of a welding application. At some point no welding shield gas demand will exist, perhaps during break time or overnight. The great majority of piping systems and/or welding machines have some leakage. If this leak rate falls into the range where the constant flow gas mixer is inaccurate, for example 0-10 SCFH, a bad mixture will be created and the pipeline will be filled with this incorrect mixture. Defective welding will result when production resumes.

Photo courtesy of Thermco

Surge Tank Gas Mixer:
Surge tank style gas mixers operate with a surge tank, solenoid valve, and pressure switch.

The Surge Tank Gas Mixer With Gas Analyzer

Combining the surge tank gas mixer and a gas analyzer creates a system which is accurate over the entire flow spectrum and has improved accuracy and monitoring capability. The gas analyzer constantly monitors the gas mixture by continuously withdrawing a small sample from the surge tank. The gas analyzer provides two important benefits. First, the gas analyzer is used in the setting of the gas mixture proportion and allows the user to easily change the mixture if desired. To change the mixture, the operator simply turns the metering valve on the minor gas and observes the result on the gas analyzer. The other important benefit of a gas analyzer is the continuous monitoring of the gas mixture quality. If a process problem should develop, for example a problem with the MIG welding, the operator can observe the analyzer and see if the problem concerns the mixed gas. Any mechanical failures in the gas mixer or loss of supply pressure will be apparent from the analysis of the gas analyzer. Alarms can also be part of the gas analysis system which will provide audio and visual indication to the user when there is a mixing problem. Also, some users require continuous monitoring for quality assurance which can be provided with an optional 4-20 mA output signal to a data logging system.

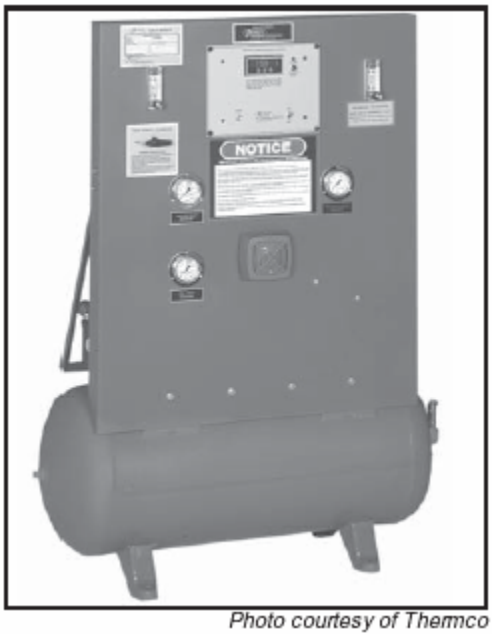


Photo courtesy of Thermco

Surge Tank Gas Mixer with Analyzer: Combining the surge tank gas mixer and a gas analyzer creates a system which is accurate over the entire flow spectrum.

The type of gas analyzer normally used with gas mixers is the thermal conductivity type. Thermal conductivity gas analyzers are ideal for this application since they are moderate in cost, simple to operate, use a non-depleting sensor, and are very stable in the zero and calibration performance. However, direct measurement with thermal conductivity gas analyzers are not suitable for three gas mixtures, since thermal conductivity is not specific for any particular gas. Gas specific gas analyzers are available; for example, infrared gas analyzers for CO_2, but these are expensive and more prone to drift than the thermal conductivity type gas analyzers.

Indoors or Outdoors?

Should the gas mixer be placed indoors or outdoors? Generally, indoors is preferred, especially in the colder climates. All types of gas mixers depend upon mechanical devices with diaphragms, and these devices will be effected by temperature swings encountered outdoors. Cold

temperatures and snow can make servicing difficult. In the warmer climates placing the gas mixer outdoors is more practical, but the installer should be sure the gas mixer is either rated for outdoor service or somehow protected from precipitation. When installing outdoors, also consider the heating that can occur in gas mixer enclosures exposed to the sun. Gas analyzers mounted in gas mixers will have an upper temperature limit that should not be exceeded.

Gas Mixer Accuracy

Gas mixers vary widely in their ability to hold a mixed gas proportion accurately under various conditions. Higher quality gas mixers define their accuracy precisely in terms of flow rate, temperature conditions, and a definition of "accuracy." Statements like "highly accurate" or "very precise" or "one percent accurate" are not meaningful unless the parameters are defined in technical terms. Comprehensive technical information should be supplied in the manufacturers literature.

Back Flow Is Not the Way To Go

Gas mixers provide a point in a system where back flow of one gas component into the supply of another component is possible. It is very important to avoid this situation. Higher quality gas mixers contain check valves to prevent back flow of gases. Without check valves, back flow can occur when one gas supply becomes exhausted and the pressure of that component to the gas mixer is reduced to the point where another component can flow back into the exhausted supply. This can cause major problems; for example, CO2 flowing back into a liquid argon vessel. In this case the CO2 will freeze in the argon vessel and the entire argon vessel will have to be blown down, the temperature raised, and the CO2 removed. Another problem is the cross-contamination in the piping caused by such an event. It is good design practice to add an additional check valve in the piping system upstream of the gas mixer. Use only good quality check valves that will close tightly even under low differential pressure conditions, but sized so there is not too much pressure drop under normal flow conditions.

Stratification of Mixed Gases

A frequently asked question is, will the mixed gases separate in a large piping system or over a long period of time? The answer is that once the gases are mixed homogeneously, they will not separate (this assumes non-condensing and non-reactive gases). This statement is true even if the gases have far different specific gravities, such as argon and hydrogen.

The Future of Gas Mixers

The popularity of gas mixers will continue as users seek mixed gas solutions that save labor cost while increasing accuracy and flexibility. Users will see greater use of gas analyzers to verify the mixed gas quality. Reliability of gas mixers will continue to increase as manufacturers adopt new technology, such as long life solid-state pressure switches for surge tank control.

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