

SRS Tech Note

Comparing thermal conductivity gas analyzers with the BGA244

Binary gas analyzers measure the ratio of gases in a two gas mixture. These analyzers determine the gas concentration by measuring thermodynamic properties of the gas mixture. In all cases, both gases must be known in order to make accurate measurements. Gases can be pure (composed of the same molecules) or blends (composed of different molecules, like air).

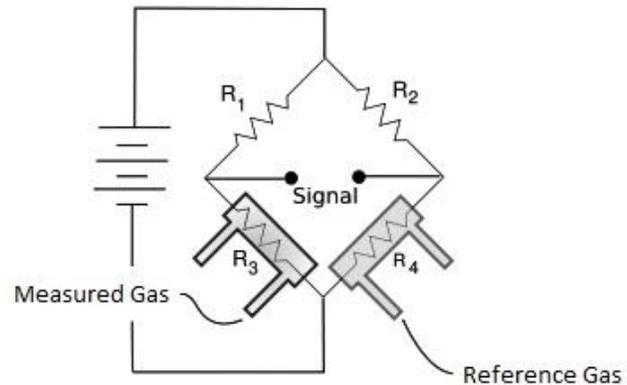
Thermal conductivity based gas analyzers, or Katharometers, have been used for these measurements for a number of years. These analyzers operate by comparing the thermal conductivity of the measured gas to that of a reference gas.

A new binary gas analyzer from Stanford Research Systems operates by measuring the speed of sound to determine the ratio of gases. This technique offers several significant improvements over thermal conductivity based analyzers.

How TC type analyzers work

Thermal conductivity based gas analyzers (TC type analyzers) measure the ability of a gas to conduct heat. Two electrically heated filaments (or thermistors) are placed in the measured gas and in a separate reference gas. The heat conducted away by each gas cools the corresponding filament, changing its resistance. The resistance difference between the two filaments gives a relative measurement of the thermal conductivity of the gases.

These sensors are normally configured as a Wheatstone bridge circuit: one leg is the reference gas filament, one the measured gas filament and the other two are precision resistors. The heating current is supplied from the top to the bottom of the bridge and changes in thermal conductivity are measured across the bridge. Heaters are normally used to stabilize the cell temperature to reduce sensitivity to changes in the ambient temperature. The reference gas can either flow through the cell or be contained in a sealed cell.



TC type analyzers are calibrated by flowing two separate gases at the extremes of the measurement range. First a “zero” gas is flowed to set the lower end of the measurement range. Next a “span” (or full scale) gas is flowed to set the high end of the measurement range. Changing gases ordinarily requires repeating this procedure with the new gases. Both the zero and span adjustments are subject to drifts of up to 0.5 - 2% per week, requiring calibration on a daily or weekly basis. This procedure can take several minutes, and usually requires extra valves and reference gas bottles.

The typical accuracy for TC type analyzers is around 1 - 2%. Changes in the temperature, pressure, flow will further degrade the accuracy. In general, these instruments provide no means to compensate for these errors.

The filaments or thermistors within the cell are usually heated to around 100 °C to ensure that the majority of heat loss is due to thermal conductivity of the gas. This high temperature can lead to the filaments or thermistors being damaged if they are exposed to vacuum, or if the gas flow stops.

How the BGA244 works

The BGA244 makes measurements of the speed of sound and temperature of the gas. The gas concentration is then calculated based on the speed of sound, temperature, molar mass and thermodynamic properties of the two gases.

The speed of sound measurement is made by injecting a wideband acoustic signal into a resonant gas cell using a speaker. The resonant modes of the cell are excited, like in an organ pipe or whistle, producing large amplitudes at those frequencies. This signal is measured using a sensitive, wideband microphone. Advanced signal processing extracts the precise frequencies of the resonant peaks. Using the frequency of the peaks and the dimensions of the cavity, the speed of sound can be calculated. In addition, the gas temperature within the cell is measured using highly stable glass bead thermistors.



Accuracy and stability is inherent to the design of the BGA244. They are determined by the physical dimension of the stainless steel resonant gas cell, the stability of a crystal oscillator and glass bead thermistors, plus the physical properties of the nearly 500 gases stored in the gas table. The long term drift of the speed of sound and temperature measurements is below ± 5 ppm/year.

The BGA244 has a 0.1% typical accuracy without any field calibration. When the highest accuracy is required, local calibration can be performed to further improve measurement accuracy. Accuracy isn't affected by changes in temperature or flow. Large pressure changes can have a small effect on the speed of sound measurements. However the BGA244 can directly compensate for this, either by monitoring an external pressure transducer, or by entering the pressure from either the front panel or computer interfaces.

The BGA244 is fully vacuum compatible and can make measurements from below atmospheric pressure to 150 psia (1030 kPa). Flow rates can vary from zero (no flow) up to more than 5000 sccm. Users have successfully operated flow rates of 20,000 sccm. The robust design of the BGA244 has no filaments or sensors to burn out, which minimizes field failures.



Using TC type analyzers

Most TC type analyzers come from the factory preconfigured for one or at most a few specific gas combinations and concentration ranges. In some cases, units can be field calibrated for different gases. However many factory configurations preclude a wide range of gases.

Systems or installations using TC type analyzers typically include valves to direct the zero and span gases to the analyzer during calibration. Supplies of both gases are required, as is a reference gas for flowing reference gas designs. These calibration procedures must be performed on a daily to weekly schedule. In some cases, this can be automated using electrically controlled valves and control software to reduce the errors due to drift.

With the zero, span and reference gases, valves and regular calibration, the cost of ownership of a TC type analyzer can far exceed the actual cost of the analyzer itself.

Using the BGA244

The BGA244 comes from the factory calibrated for nearly 500 different gases. This allows over 50,000 different gas combinations, nearly all of which support a full 0 -100 % concentration range. Gases can be easily selected from the front panel, over one of the computer interfaces, or using the free BGAMon software.

The BGA244 doesn't require zero or span calibration to achieve 0.1% accuracy. This eliminates the need for reference, zero and span gases, plus the valves, labor or software needed to perform them, leading to a lower cost of ownership. This, plus the improved accuracy and wide range of gases, dramatically improves the value proposition for the BGA244 when compared to other analyzers.

Conclusions

The BGA244 offers dramatic improvement in performance and value compared to thermal conductivity based gas analyzers.

- Ten times better accuracy
- Thousand times better stability
- Lower cost of ownership due to reduced installation cost and maintenance
- Greater flexibility with ~500 pre-calibrated gases and no recalibration to change gases

Contact

Visit our web site at <http://www.thinksrs.com/products/BGA244.htm> for additional information.

Or call us at 408-744-9047 to discuss your application.



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Comparison Table

Comparing the BGA244 with several leading TC type gas analyzers

	SRS BGA244	GE TMO2-TC	Honeywell 7866	Gow-Mac 50 Series	Thermco Model 7000
Accuracy	±0.1% typical	±1% of span	±2% of span	±3% of FS on meter ±1% on recorder	± 0.3 to 2 % of FS depending on concentration
Drift	±5 ppm/year	Zero: ±0.5%/week Span: ±0.5%/ week	Zero: ±2%/week Span: ±2%/ week	±1% / day	Zero: ±2%/week Span: ±1%/month
Gases supported	~500 plus user defined gases	Preconfigured for single gas pair or field configurable	Preconfigured for single gas pair or field configurable	Field configured	Preconfigured for 6 gas pairs
Flow Rate	0 – 5000 sccm	50-2000 sccm	100 – 2000 sccm	0 - 472 sccm	472 sccm
Working Pressure	5 – 150 psia	Atmospheric (10-15 psia)	+ 0.7 psig (atmospheric)	2 psig (atmospheric)	1-150 psig
Calibration & Reference Gases	None required	Zero, Span gas Optional Ref gas	Zero, Span gas Optional Ref gas	Zero, Span gas, Optional Ref gas	Ref gas Zero gas
Display and user interface	Touchscreen LCD display	Optional external control unit	External control unit	Analog meter Optional Digital meter	Analog meter Optional Digital meter
Computer interface	USB, RS-232, RS-422	RS-232	Optional RS-422, RS-485, MODBUS	n/a	n/a

