# How Bascom-Turner Natural Gas Sensors Work

Bascom-Turner natural gas (methane) sensors combine catalytic detection with thermal conductivity to provide high sensitivity and high reliability over the entire range (0 to 100%) of gas. Catalytic detection is used up to about 5% gas, i.e., the lower explosive limit (LEL) of natural gas. Thermal conductivity measurements are carried out from 5% to 100% gas. This arrangement combines the high sensitivity of catalytic detection with the high reliability of thermal conductivity measurements to yield a sensor well-suited for leak detection while at the same time appropriate for bar-holing.

**Conventional Catalytic Sensors**

Conventional catalytic sensors consist of a pair of beads made from coils of platinum wire embedded in a ceramic, usually aluminum oxide. One bead is catalytically active for combustible substances while the other is inactive and serves as a reference. The beads are matched in resistance and serve as two arms of a Wheatstone bridge. Combustion of a gas on the catalyzed bead raises the resistance of the platinum coil embedded within it and the resulting bridge imbalance is detected as a voltage roughly proportional to the concentration of the combustible vapor or gas.

**Drawbacks of Conventional Catalytic Sensors**

Conventional catalytic sensors are inefficient in utilizing battery power and capacity. Maintaining two beads instead of one bead at an elevated temperature wastes half the power. A resistance bridge is precise, but it doesn’t actually yield a quantity proportional to the gas concentration. The fact that the resistance of the active sensor changes upon exposure to a combustible gas means that its temperature also changes. If the temperature change is small, this change is proportional to the gas concentration, but in general, if the temperature change is significant, the relation between temperature change and gas concentration will not be linear. What yields accurate results is measurement of the power required to keep the sensor at a fixed temperature as a function of gas concentration.

The reference bead used in conventional sensors is intended to compensate for effects of ambient temperature and humidity. Ideally, the reference and the active sensor respond identically to changes in ambient conditions. In practice, the beads can’t be exactly the same nor can they be identically situated. The divergence in response manifests itself as an offset which depends on ambient temperature and humidity.

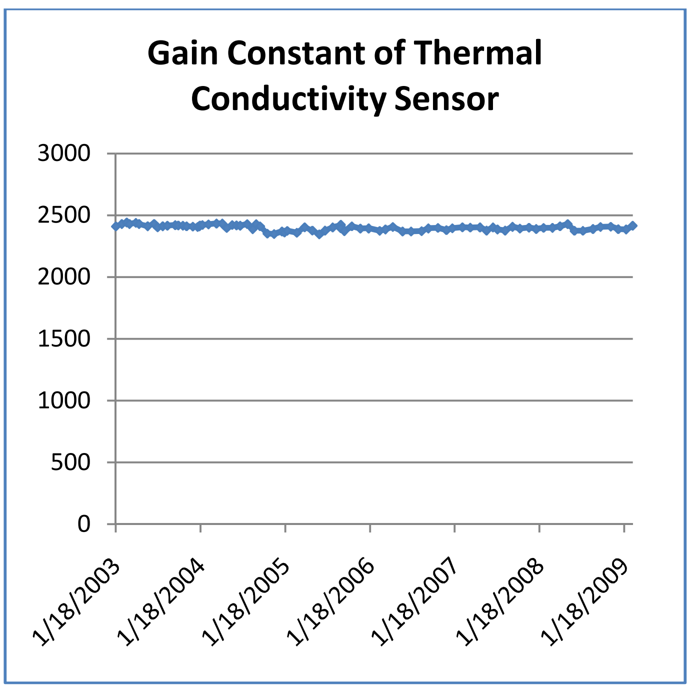
**The Bascom-Turner Natural Gas Sensor**

The Bascom-Turner methane (natural gas) sensor was designed to minimize effects of airborne catalyst poisons, utilize battery power efficiently, optimize linearity of response, compensate ambient changes, and span the whole range (0-100%) of gas with reliability, particularly in the flammable range (5-15%) and higher.

The basic approach to management of the gas sensor in Bascom-Turner instruments is power modulation. Power modulation allows significant savings in energy (up to 70%) and therefore operations at higher sensor temperatures. This, in turn, allows the use of materials that are more resistant to common airborne catalyst poisons, such as sulfides and chlorides. At the higher operating temperatures, such surface contaminants are either thermally desorbed or decomposed in the presence of air (oxygen).

Power modulation allows corrections for the effect of ambient temperature and humidity using a single bead at two different temperatures. Since the same bead is used for both measurements, all geometrical and situational factors cancel. Compensation is therefore strictly dependent on the control of the temperature of the sensor. Sensors are individually controlled at a chosen temperature by appropriate electronics; the precision is ultimately dependent on the precision of electronic control, which can be very high.

All Bascom-Turner gas sensors combine a catalytic bead with a thermal conductivity sensor. The first responds in varying degrees to essentially all combustible gases. It is, of course, calibrated with respect to the gas of interest—in most cases natural gas. The thermal conductivity sensor is applicable to natural gas (methane) and propane, and complements in many respects a catalytic sensor. It does not require air (oxygen) for its operation; it is not sensitive to surface conditions, but responds to bulk changes of the sampled gas. It is not as sensitive as a catalytic combustion sensor, nor is it applicable to all combustible gases. However, it is an indispensible sensor for methane and propane and covers the whole range of gas up to 100%. Finally, since it is independent of surface processes and responds only to bulk properties of the sampled gas, it can be relied upon to maintain a fixed gain over years of field service (see box.)




**Gain Constant of Thermal Conductivity Sensor**

| Date | Constant |
|---|---|
| 1/18/2003 | 2409 |
| 1/5/2004 | 2405 |
| 1/14/2005 | 2361 |
| 1/12/2006 | 2393 |
| 1/5/2007 | 2395 |
| 1/4/2008 | 2388 |
| 1/26/2009 | 2385 |
| Average over 6 years of field use (74 cals) | 2396 (±0.68%) |

Box 1. Gain constant for typical thermal conductivity sensor tracked over 74 calibrations and 6 years of field use (graphical and tabular views show same data.)

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