THE TRUTH ABOUT CO SENSORS IN THE PRESENCE OF NOx

In residential and light commercial combustion analysis there are several important combustion gas components that are monitored: Oxygen (O2), Carbon Monoxide (CO), Carbon Dioxide (CO2) and NOx (a combination of Nitric Oxide (NO) + Nitrogen Dioxide (NO2)). These are measured to determine the proper setup of a furnace for efficiency, safety, and, environmental compliance.

Depending on the setup of the combustion source there are varying levels of O2, CO, and NOx. These gases are byproducts of the all combustion sources regardless if you are working on a residential furnace or a huge combustion turbine. Therefore, the combustion analyzer will pump a blend of all these compounds past the sensors.

The measurement of these combustion compounds can be accomplished by many different methods including laboratory grade analyzers, however these analyzers cost thousands of dollars, and are so delicate they are not able to maintain calibration over the many changing conditions that a service contractor experiences. Because of industry needs and with advancements in technology, manufacturers have developed stable, portable and cost effective combustion analyzers using electrochemical sensor technology.

Electrochemical sensor technology is similar to the concepts used in automotive batteries where you are relying on the chemical reactions between dissimilar metal components within an acid solution to create an electrical output. Although the electrical output is very small by comparison the electronics of the analyzer amplify and condition the signal into very accurate measurements.

What is especially unique about electrochemical sensors is that they rely on the chemical reaction between the targeted gases from combustion and the chemical solution inside the sensor. As the targeted gas, (e.g. CO) comes in contact with the chemicals inside the sensor a new chemical cocktail is formed that reacts with the metal electrodes creating electrical output. When the CO, is gone, the chemical reaction is completed and the electrical output stops.

Many factors go into the design of an electrochemical sensor to ensure it will reliably detect both low and high levels of a specific gas and so it will do so over a wide range of operating conditions. Of extreme importance for a measurement sensor to have any value, it must isolate a single measurement parameter while remaining unaffected by the wide range of variability in all things it will be exposed to during the test.

For instance, what would result if a sensor responds to gases in addition to the gas for which it is targeted? Unfortunately this undesirable reaction occurs when CO sensors of certain manufacture are exposed to NOx. Because of poor design, the result is an additive output where you witness the entire CO reading plus a significant percentage of the NOx exposure.

Testo Inc.
(800) 227-0729
40 White Lake Rd.
Fax (862) 354-5020
Sparta, NJ 07871
e-mail: info@testo.com

Because of this dual reaction, it is impossible to know how much of the output is due to CO and how much is the result of NOx. You would be reading a high and "*false CO*" value and couldn't determine anything accurately at all. This phenomenon can certainly explain why some analyzers seem to have a lower CO reading than the poorly designed and less expensive analyzers.

Accurate carbon monoxide readings in combustion sources are critical as CO is a leading indicator of incomplete combustion and, much more importantly, is the well-known "silent killer". In today's equipment, high levels of carbon monoxide emissions primarily result from incomplete combustion due to poor burner design or firing conditions, eg. improper air-to-fuel ratio or a misaligned burner. Through proper burner maintenance, inspections, and operation a service contractor can help control CO at acceptable levels.

In some government weatherization programs and in building performance testing guidelines, specific levels of CO dictate that corrective actions are taken. It is a problem if time consuming and costly actions are taken when based on readings of "false CO."

Poorly designed CO sensors take little or no consideration of the NOx cross-sensitivity in combustion applications and they then have an additional output of 20-50% due to the NOx value. That means, for instance, in a flue gas with 100 PPM CO and 200 PPM NOx the CO sensor will show 100 PPM for the CO plus an additional 40 - 100 PPM. *This means an error of 50-100% on CO*.

This is the unfortunate situation with many of the hand held electrochemical analyzers on the market today. These companies advertise sensors that accurately report CO but they do not indicate they are also reacting to NOx. Without this knowledge countless hours of service time is wasted as contractors try to mechanically correct problems that do not exist. Attempts to lower CO levels by decreasing flame temperatures or residence time will result in overall decreased combustion efficiency and may not have been necessary.

How does Testo prevent cross sensitivity in CO sensors?

For decades Testo has used CO sensors with NOx filters. More than 10 years ago, Testo pioneered sensors with renewable NOx filters. These filters scrub and remove all the NOx from the gas stream. This prevents NOx from ever reaching the sensor. This special filter or *NOx Scrubber* is designed to last longer than the life of the sensor so there is no maintenance required under normal operating conditions.

How can I tell if my sensor has a filter and if it is working properly?

Simply challenge the combustion analyzer with NOx as you would a normal calibration gas. If a NOx filter is present and properly scrubbing you will see 0 PPM CO in the display. If there is no filter or a poorly designed filter you can expect to see 25-50% of the value of the NOx gas as CO reading on the display.

Testo Inc. 40 White Lake Rd. Sparta, NJ 07871 (800) 252-1720 Fax (862) 354-5020

The costs and time involved in purchasing, safely using and conducting calibrations is usually the role of a specialist. Why not ask your combustion analyzer manufacturer or calibration service to conduct the “NOx challenge” on your combustion analyzer?

Filtering the NOx from the combustion gas before it goes through the sensor is a fundamental to achieving accurate CO readings. Without a NOx Scrubber you will never know what your true CO reading is because it will vary with changes in NOx.

Other specialized CO sensors exist on the market; but don’t be confused by “Hydrogen compensation” of a CO sensor as is not necessary unless excess air is extremely low – a situation rarely encountered in residential or light commercial applications.

Of course the additional technology that goes into a well designed sensor and analyzer may cost a little more, but “reading wrong” is the one of the most expensive readings you will ever make!

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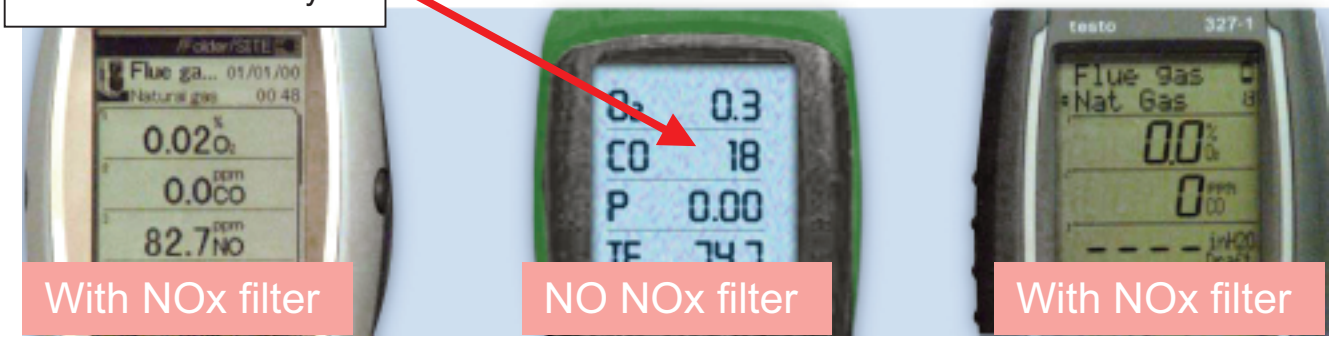
Zero Sensors with Fresh Air

CO Cal Gas to check sensor output

83 PPM NOx shows CO cross-sensitivity



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