

HBB Pro Sales Group Tech Note

Properly interpreting combustion analyzer Carbon Monoxide readings

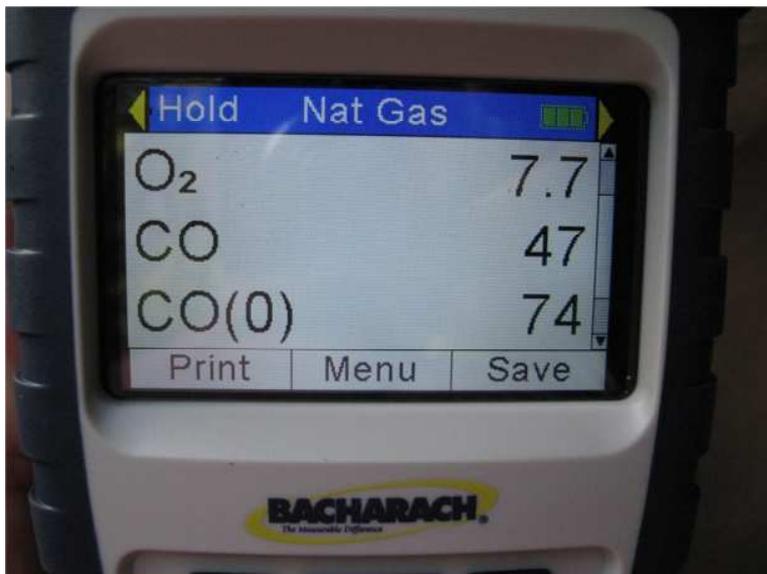
Modern combustion analyzers have two distinct Carbon Monoxide (CO) readings in the display.

Both readings are expressed in 'parts per million' or the number of CO molecules in one million molecules of air.

The first we will discuss is simply the CO reading, often referred to as 'as read' or 'diluted' Carbon Monoxide reading. This reading is only to be used for ambient air readings, which, by the way, should be no higher than outside levels. If a higher level is recorded inside a structure it means CO is being produced and that there is a direct path for that CO to reach the occupants of the building.

The second reading is referred to as the CO air free reading. It is also termed 'COAF' or 'CO as measured on an air free basis'. This CO reading is only to be used for flue gas CO readings and compensates for the amount of dilution Oxygen (O_2) in the flue gas sample.

O_2 left over after the combustion process dilutes down the amount of CO in the flue gases.



Note the three readings in the photo above. The first reading is the amount of Oxygen left over after the combustion process. Air is approximately 21% Oxygen with the remaining 79% primarily consisting of Nitrogen. Most heating equipment burns all but 3% to 9% depending on the equipment being tested

The second reading (47 ppm) is diluted down by this Oxygen with the third reading (74 ppm CO-AF) is based on a calculation which eliminates the Oxygen from the flue gas sample.

HBB Pro Sales Group Tech Note

The mathematical calculation is below but the instrument should do the calculation automatically.

$$\frac{20.9}{20.9 - O_2} \times CO = CO \text{ Air Free}$$

Mathematically eliminating the dilution air allows for a direct comparison of flue gas levels.¹

To help understand this, let's compare two identical cups of coffee. The first we add two spoonfuls of cream, the second we add four spoonfuls of cream. Now they are different temperatures, colors and volumes – however, they still have identical amounts of coffee. One is diluted more than the other; the cups of coffee cannot be accurately compared without taking out the cream.

The CO-AF reading is like mathematically taking the cream back out of the coffee and is the unit of measurement for the national standard. At 400 ppm CO-AF, most authorities of jurisdiction require equipment be shut down.

Many consider 100ppm CO-AF to be achievable once the equipment reaches steady state conditions, always check with the manufacturer of the equipment being tested to verify maximum acceptable CO-AF levels as well as typical flue gas O₂ and stack temperature ranges.

Also, keep in mind that some equipment may display higher CO-AF readings on light off, there are no standards for maximum levels of CO-AF when the burner first ignites, learn CO readings are unusual.

Another reason to observe the CO (as measured) reading on light off and shut down on power burners is to protect the CO sensor from overexposure. Sensor overexposure can result in voiding the manufacturers' warranty and may damage or throw the sensor out of calibration.

Experience has shown CO sensors can take a lot of abuse but it is good practice to avoid sensor over range.

¹ Most analyzers don't start calculating CO-AF until the O₂ reading reaches 16% - 18%.