Carbon Monoxide & Dioxide

You might not get too many calls for these complaints, but when you do, you need to know what you're dealing with as improper diagnostics and understanding can be harmful to the owner's health. There are a lot of ways you can go wrong in your diagnostics, so understanding what the differences between the two are, and the proper testing methods is vital to doing your job right.

Example

I was called to a unit where a plumber determined an oven was emitting too much CO. Going off his readings, he shut off the gas supply to the oven, documented his findings on a Red Tag with a big warning to not use the oven, and advised the customer to call an appliance company. I inspected the Red Tag and saw that he wrote: "CO levels too high." His handwriting was on par with that of a doctor in a hurry, and provided no further information.

When you're called out and see documentation like that, it's easy to think to yourself: Well, to be a plumber, you've got to be certified and licensed. And he had an official-looking Red Tag. Clearly, this guy is legit. For me, when I see vague documentation like that, I start to question everything. What were the levels? Where did he make his checks? What type of meter was he using?

All of those are relevant questions, and we're going to go over why.

Introduction

When dealing with gas appliances, it's crucial to understand the difference between **carbon monoxide (CO)** and **carbon dioxide (CO_2)** emissions, both of which result from combustion but have very different properties and implications.

Carbon Dioxide (CO_2):

- **What it is:** CO_2 is a naturally occurring, non-toxic gas that is a normal byproduct of complete combustion.
- **Formation:** In a gas appliance, when fuel (like natural gas or propane) burns with the right amount of oxygen, it produces water vapor (H_2O) and carbon dioxide (CO_2). This indicates the appliance is operating efficiently.
- **Key points:**
    - It's not harmful in typical quantities produced by appliances.
    - It's an indicator of good combustion.
    - Excess CO_2 in a poorly ventilated area can still be a concern, as it displaces oxygen.

Carbon Monoxide (CO):

- **What it is:** CO is a colorless, odorless, and highly toxic gas that is a byproduct of incomplete combustion.
- **Formation:** If there's not enough oxygen present during combustion (a condition called **incomplete combustion**), CO is produced instead of CO_2. This can happen if:
    - The burner is dirty or clogged.

    - The appliance isn't properly vented.
    - The air-to-fuel ratio is off.
- **Key points:**
    - CO is dangerous and can cause poisoning, leading to symptoms like headache, dizziness, confusion, and even death in high concentrations.[1]
    - It's a sign of poor combustion and often indicates a problem with the appliance that needs to be repaired or adjusted.

Practical Takeaways for Technicians:

1. **Combustion analysis:** Use a combustion analyzer to check the levels of CO and CO_2 in the flue gases.
2. **Safety checks:** Always ensure the gas appliance is properly vented and maintained. Look for blockages, cracks, or signs of malfunction.
3. **Signs of trouble:** Yellow or flickering flames, soot buildup, or condensation near the venting system often indicate incomplete combustion and the potential for CO production.

CO Levels

What are allowable tolerances? Different manufacturers have different tolerances, and when you hop online to do a search, you'll see a variety of responses anywhere from 1,000 ppm (**parts per million**), down to 100 ppm. Bottom line is, there is some variation to it. Factors include the type of appliance, and the potential for extended run time.

Per Whirlpool documentation[2] 400 PPM is allowable, but again, that varies from if it's a self cleaning oven or not. If it's above that, then some "minor adjustments should be made."

That being said, the information the gas company documented on the Red Tag was woefully inadequate. To him, it might have made complete sense, but **when it comes to documentation, it cannot make complete sense to *just* you**. It has to make sense to anyone reading it, and they should be able to conclude that you made the right decision. And this is paramount to the documentation that you do as an appliance repair technician on any service call you're out on.

Side note on that: When you're working on your documentation, I look at it in two ways:

1. I write it as if it were going to be scrutinized in court to defend my actions. A prosecuting attorney would have an absolute field day if all my notes said were "CO levels too high." I would sit there on the stand, having to detail my process, and then they would question my memory of the events, since it was not documented.
2. If I have detailed notes, and someone else looks at them and says, "Why did you make this test in this manner?", I can explain why, and they can let me know if they disagree, or if they have a different method. In this field, there is almost always a better way or another way to do something. Some might be more efficient than the other. You won't know this if you're hiding what you're doing.

[1] https://www.cdc.gov/carbon-monoxide/about/index.html
[2] Job Aid Part No. 4322259

Testing Equipment

Let's square this away right here, right now. The meter you use matters. There are different types of gas detection meters out there, and I have seen techs use the wrong meters to test for CO. In this line of work, documentable metrics are your best friend (as I have been preaching). They give you solid numbers to write down and later refer to. Consider it like this: You're out on a service call following another tech. The evaporator fan is not working. That tech's note says "good voltage." You get there, and you find the voltage to be completely wrong. What was he considering "good voltage"? … Don't be *that* guy.

Combustible Gas Meter

A combustible gas meter is generally one that will start to beep when a combustible gas is present. The stronger the gas, the faster the beeps. These meters are great if you're looking to see where the odor of gas is coming from. You run the wand along where the gas flows, and it will audibly indicate when it starts to smell the gas.

For these, you simply take them outside where there is no gas odor, you turn them on and allow them some time to calibrate in an area where there is little to no gas so it has a baseline. You then take it back inside, and run it along the gas tubes.

Here's the thing, though, and this is where some techs mess up: **CO (carbon monoxide) is not a combustible gas**. In fact, CO is often used as a fire extinguishing agent because it does not support combustion.

Do not use a combustible gas meter to check for CO. The meter will start going crazy because, as mentioned above, CO can occur due to **incomplete combustion** or **inadequate ventilation.** This meter is picking up the odor of gas, which is normal, not the presence of CO.

Combustion Analyzer

A combustion analyzer measures the concentration of gasses like CO_2 and CO . Bottom line is, if your meter is not going to tell you the **PPM of the CO levels**, then you're wasting your time. You might as well be waving a Harry Potter novelty wand at the stove and waiting for it to illuminate the CO_2.

As mentioned previously, you need metrics to which you can compare. We know that we are looking for the oven to put out less than 400 PPM (unless documentation for that unit says otherwise). We need a meter that can tell us how many PPMs are present. A meter that beeps at you is useless unless you smell gas and are trying to figure out where it's coming from.

Wouldn't it have been useful if the gas company red tag said: "Oven putting out 976 PPM"? We could have used that to compare to our own readings based on our own tests.

Again, I cannot stress this enough: **Documentation is key**. Even if you work for yourself. I have looked back at some of my documentation from when I first started, and had no clue what I was talking about, or could not come to a conclusion on what the issue might be based on the tests I had written down.

Testing Method

Alluding to the same Job Aid listed above on testing for CO levels, let's look at how you should be testing CO levels. When you get your proper combustion analyzer that will tell you the PPM levels, take the time to read the instructions. There are precise ways to calibrate them before use to prevent false or inaccurate readings.

Last thing you want is to chase high CO levels that are not correct because you failed to calibrate your meter properly, or you had your meter sitting next to the stove during the initial start up process.

1. Set the oven to bake at 500°F to ensure the gas does not cycle too much during testing.
2. Let the oven operate for 5-7 minutes before measuring is attempted.
3. Place your test probe into the oven vent.
4. Wait for the CO PPM levels to stabilize.
5. Record your test results.

Stove Top Burners

You cannot check for **CO** and **CO_2** levels on stovetop burners in the same way you would for a vented gas appliance like an oven because of several key differences in how these appliances operate and are designed. I am going to try and break this section down into digestible segments.

Lack of a Controlled Flue or Vent System

Ovens have a **dedicated exhaust system** to direct combustion gases (CO, CO_2, and others) out. This allows technicians to test flue gases directly for combustion efficiency and safety. In other words, they confine and channel the exhaust gases, allowing precise testing at the flue or vent.

Stovetop burners are **unvented** and release combustion byproducts directly into the room air. Without a concentrated exhaust stream, it's impossible to measure gas levels accurately, as the byproducts disperse into the surrounding air immediately.

Different Air-to-Fuel Ratio Requirements

Stovetop burners are designed for visible flames in an open environment, which requires a **different air-to-fuel ratio** than an oven, which is enclosed. Stove tops deliberately use excess air to ensure complete combustion in a non-contained space.

This excess air reduces CO production but also makes it harder to measure CO_2 levels since the combustion is less concentrated.

Primary Focus is Visual Flame Inspection

For stovetop burners, technicians rely on **flame characteristics** to assess combustion:

- **Blue flames** indicate proper combustion.
- **Yellow or orange flames** suggest incomplete combustion (e.g., due to dirt, clogged ports, or improper gas pressure) and a potential for CO production.

Ventilation is Key for Safety

Stovetops rely on the room's ventilation to disperse combustion byproducts safely. This is why proper kitchen ventilation (e.g., range hoods or exhaust fans) is essential to prevent CO buildup during use.

Contaminants & Orange Flames

Orange flames can occur on gas burners without soot because the color isn't always caused by incomplete combustion.

Instead, **contaminants in the air** can change the flame color. Contamination could be cooking oils, aerosol sprays, dust, etc., and it will enter the flame and can incandescence at high temperatures, which emit an orange or yellow flame. Despite the orange color, the combustion can still be complete, which is why **no soot** is produced.

Humidifiers: Humidifiers release **water vapor** into the air, which can collect and carry those small particles like dust or minerals from the water.

Alternative CO Safety Measures

For stovetops, you can’t test emissions directly, but you can use an **ambient CO meter** to check the general air quality in the kitchen while the burners are running. If CO levels rise significantly, it indicates poor combustion or insufficient ventilation.

Placement of the Carbon Monoxide detector is also important. I have seen some customers who have it in the kitchen, above the

Summary

We went over a lot here, but it’s important information. You will get customers who see an orange flame, and who will absolutely lose it and will need solid reassurances from someone who knows what they’re talking about. When you’re faced with a situation like that, understanding how combustion works and how to properly diagnose, is paramount.