**Oil Diagnostic Chart Troubleshooting**

Note: These numbers were developed using an analyzer with a faster pump and response. Because most newer analyzers are slower the Light-off and Shut-Down readings will be lower. Any CO readings at Light-off and Shut-Down near 100ppm could be considered excessive.

Also analyzers with NOX filters will give lower CO readings during the Run Cycle only.

**Typical Acceptable CO Patterns**

 **Light-off Run Run Run Shut-Down**

1. **ppm 80 50 50 50 55-60-55**
2. **ppm 50 10 10 10 10-9-5**
3. **ppm 10 0 0 0 2-5-3**
4. **ppm 0 0 0 0 0-0-0**

Yes, it is possible to have 0ppm CO on oil, but it is rare. However when it is 0ppm at the Light-off and Run, it must be 0ppm at Shut-Down. The following pattern s not acceptable.

 **Light-off Run Run Run Shut-Down**

 **1. ppm 0 0 0 0 10-50-10**

If CO is 0ppm from the very start it should stay at zero at the end. This is a sign of slight impingement on the flame cone.

**Problem #1 – Air in System**

 **Examples**

  **Light-off Run Run Run Shut-Down**

 **1. ppm 150 30 30 30 60-90-130-100**

 **2. ppm 200 50 50 50 80-130-170-120**

Only Light-off and Shut-down are above 100ppm. This is normal when servicing an oil burner and changing the filter because there is some air in the filter and possibly the oil line. If this is te only problem the CO should fall each consecutive cycle.

**Examples – self correcting**

 **Light-off Run Run Run Shut-Down**

**Cycle#1 150 30 30 30 50-90-130-100**

**Cycle#2 110 30 30 30 60-80-100-70**

**Cycle#3 90 30 30 30 50-60-80-60**

If the CO does not go down and possibly goes up, then Problem #2 has to be considered

**Problem #2 – Leaky Fittings or Pump Seal**

**Examples**

 **Light-off Run Run Run Shut-Down**

**Cycle#1 150 30 35 40 70-100-130-120**

**Cycle#2 170 35 40 45 90-120-150-130**

**Cycle#3 200 40 45 50 100-140-180-150**

Here the problem I getting worse which means more air is leaking into the system. This could be a gasket leak on the oil filter. Using a vacuum gauge and heavy grease would be the proper method to find the leak.

**Problem #3 – Bad Nozzle or Underfired**

**Examples**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 120 110 110 110 112 -115-110**

 **2. ppm 200 150 150 150 160-180-150**

All the numbers are above 100ppm but they are fairly close together. This is seems to be the only time this occurs. This is not a wrong nozzle, it is a bad nozzle right out of the box. What is the difference between a bad nozzle or slightly Underfired? If Underfired was the problem then the flue temperature would be on the low side. Also the pump pressure with this pattern is close to 100psi. Increasing pump pressure would identify one from the other because pump pressure would not correct a bad nozzle.

A real important service tip at this point is you don’t have to change the nozzle if it is good. Nozzles do not wear out and if they are dirty the CO would let you know. Here is one more example of CO readings that say “**don’t change the nozzle”.**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 20 10 10 10 15-5-0**

If this was the CO pattern on your oil burner when you started, the biggest mistake here would be to change the nozzle. Forget what might have been said earlier about choosing the correct nozzle. These numbers indicate this is an almost perfect nozzle – Don’t Touch!

**Problem #4 – Electrode/Tranformer**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 300 40 40 40 50-30-10**

The only time the CO is above 100ppm is at Light-off.

**Problem #5 – Bad Pump Cutoff**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 70 20 20 20 40-100-300-600**

The only CO above 100ppm is at Shut-down which indicates oil is still squirting. This is more than just after-drip. This is similar to Problem #7 but the CO during the Run Cycle will be different.

**Probem #6 – Impingement on the Flame Cone**

**Examples**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 20 10 12 15 20-40-80-110-80**

 **2. ppm 5 0 1 2 4-20-40-60-40**

This is a sign of slight impingement, usually on the flame cone. Could be the drawer assembly is back too far or the nozzle angle is too wide. The second example doesn’t show the CO going over 100ppm, but the rise at the Shut-Down just doesn’t match the other CO readings. Visual inspection will certainly determine if his is true.

**Problem # 7 – Impingement on the Combustion Chamber**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 40 20 30 40 50-8-120-180-200**

This is the oil spray hitting the back of the combustion chamber because the drawer assembly is too far forward, the nozzle spray angle is too narrow or there is too much excess air. O2 will determine if the air is too high and moving the drawer assembly will determine if that is the problem or it is the nozzle.

**Problem #8 – Primary Air is Low**

**Examples**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 300 200 200 200 250-350-500-700**

 **2. ppm 150 0 0 0 50-200-400-800**

Odds are when the primary air is too low the oil burner is going to be smoky. Also the O2 reading will be on the low side. Notice that even though the burner ma be making #4 to #6 smoke, the CO could be #0 during the run cycle. CO and smoke are two different things when it comes to oil. You can have either one without the other.

**Problem #9 – Primary Air is High**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 40 30 35 40 35-40-50-60-50**

The cooler flame and high velocity of air is blowing some of the oil droplets outside the hot flame. A higher O2 reading would also be noted.

**Problem #10 – Cavitation/Oil Line Restriction**

**Examples**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 70 75 85 95 110-140-170-200-180**

 **2. ppm 120 140 160 180 200-250-300-280-250**

CO may start above 100ppm because there could be air in the line or start just below it. There is sputtering of the oil causing an erratic flame pattern and possible impingement. Two line systems, restricted supply lines or dirty oil filters can all create ts CO pattern.

**Problem #11 – Underfired**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 40 600 600 600 400-200-100-80**

Underfired was previously mentioned in Problem #3, but this time it is really underfired regardless of the pump pressure. The flue temperature is really going to be low. In this case the pump pressure could be 160psi so it might not be able to be increased. In most cases a larger nozzle is going to be necessary.

**Problem #12 – Overfired**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 230 700 700 700 800-1000-1500**

As with low primary air there is a good chance there will be a lot of smoke. A key measurement here would be the flue temperature. Opening up the air shutter on the burner may eliminate the smoke but it will only make the flue temperature higher. This could of happened when a contractor servicing this unit didn’t know the pump pressure had been increased because he doesn’t check things like that and put in too big a nozzle.

**Problem #13 – Delayed After Drip**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm N/A N/A N/A N/A 50-40-20-10-5-10-50-80-120**

No numbers were listed under Light-off and Run because they could be any thing if a second problem was present. The problem here is the Shut-Down seems to be going fine but after 30 or 40 seconds the CO rises quickly. This is usually caused by a mechanical room depressurization problem causing the draft to drop to -.00”w.c. as soon as the burner shuts down. Normally on other atmospheric gas appliances this would have shown up from the beginning as a combustion air problem. On oil, the burner motor and blower can overcome most negative pressure problems while the burner is running. Once the burner stops the draft disappears. This causes the heat in the combustion chamber to migrate into the air tube of the burner, heating up the oil in the drawer assembly. As soon as it gets hot enough the oil squirts out the nozzle and produces a high CO reading. Another problem that has been observed in the field is when a tile or brick chimney was wet. This also caused an immediate loss of draft at Shut-Down and then the delayed after drip. This is a good reason to pay attention to the combustion readings and draft for at least a minute after the burner shuts down.

The last issue, which might have been the first time this was observed in the field was when an oil appliance was sidewall vented. Because of inadequate post-purge or none at all the heat migrated back into the burner air tube. A smell of fumes or oil would also be fairly common. This was a definite problem on the earlier condensing oil furnaces.

**Problem #14 – Residual Oil in the Combustion Chamber**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm N/A 20 20 20-50-80-150 160-200-250**

There is a delay in the CO rising like the previous problem only this is occurring during the Run Cycle. Whether it is from someone pushing the reset button, once, or twice, maybe three times or excessive build up from impingement on the combustion chamber, there is a delay in this oil getting heated. Once heated it will start to off gas CO. Eventually it might start to burn which could cause an overfired problem. There is a good chance some smoke is being produced but not always. This oil does need to be burned off. Opening the air shutter temporarily to keep it from smoking is a good thing. Terminating testing early or not paying attention to the combustion readings the whole time, can lead to certain problems being overlooked.

**Problem #15 – Pulsating/Interrupted Ignition**

**Example**

 **Light-off Run Run Run Shut-Down**

 **1. ppm 30 10-20-15-20-10-15 50**

These are some readings that have been noted on residential oil burners where the spark is not constant(intermittent). The spark is terminated once the flame has been established. Although it may not be noticeable, the oil spray coming out of the nozzle can slightly pulsate. This could definitely cause some flame failures on 2-line systems because of cavitation. If the pulsation is more serious it can lead to impingement an sooting. This doesn’t happen all the time but when it does changing the spark operation may be necessary. Under most lab conditions this problem is less likely but that changes in the field.

There have been cases on commercial oil burners where the interrupted spark has caused burners to rumble and vibrate severely.

These are the 15 Oil CO Diagnostic patterns. Some are similar but can be isolated using O2 readings and flue temperatures. There can be more than just one of these problems at a time which makes diagnostics a little tricky. Using the process of elimination narrows the problem down