

Boiler Performance in Review

INO8 has sold waste oil burning boiler systems for over 23 years and has numerous customers throughout the United States, Canada and around the world saving money by burning their available waste as fuel. Most of the boilers sold have been Buderus cast iron sectional boilers though successful operations have also been in nearly every boiler manufactured. The installations vary and are creative in their energy savings and most customers are very happy with these systems. However, this article is about ways to help those that struggle with performance that is sub-standard. This doesn't have to be the case as there are many things that cause problems that can be easily corrected. If the burner is not performing as expected we can perform a reconditioning service or simply put it on our test stand for observation and repair any failing component and make sure all settings are proper. Often onsite installation is causing problems. The following are common issues that can be corrected onsite and make huge differences in overall system performance.

In 23 years of supporting waste oil burning, we've learned the importance of **1) a hot combustion chamber**, **2) a properly working chimney**, and **3) good oil quality**. Following is a list of items that contribute to good results in each of those three categories. Please review them and evaluate if your system may be deficient in a particular area. There is more detail on our website or by calling and asking for boiler technical assistance.

1. If the ash in your boiler is not white or light in color (as shown in the photo at right) and talcum powder consistency, you are not getting the best possible combustion. Because of the relatively high flash point of waste motor oil and biofuels, a hot combustion chamber is vital to achieving complete combustion. INOV8 assures a hot combustion chamber with these modifications and settings:
 - Make sure there is a stainless steel piece in the bottom of the combustion chamber. Over time it will corrode and may need to be replaced. Its purpose is to radiate heat back into the flame and to provide a shield from the cool boiler walls. Also, if oil sprays onto the steel it fries off quickly.
 - There should be a stainless steel sleeve installed through the insulation on the door. It too may corrode and require replacing. Its purpose is to keep oil from damaging the door insulation and help drive heat into the flame.
 - The Aquastat setting must be 180 °F or higher. That can be challenging in the spring and fall when the outside temperatures don't require such a hot boiler. If that is your issue, contact us for options.
 - Return water from the floor should be first mixed with hot water before entering the boiler as it cools the boiler which may quench combustion before all fuel is consumed. Mixing valves may be needed.
 - Not enough combustion air (open air band or air plate) but not so much that the boiler rumbles or causes the flame to lift off the nozzle. Without a draft gauge the best way to set the air band, is to close it until smoke is seen in the chimney, and then open it until the smoke goes away.
 - The oil preheat temperature may need to be increased. Preheat temperatures on boilers are factory set at 150 and 120 (interlock). Of course the best setting is determined by the flash point of your oil. If the oil gauge slowly moves, lower the temperature five degrees until it stabilizes. If the oil gauge bounces fast, then there is an air leak in the oil delivery line. If there are sparkles in the flame, then increase the oil preheater until the sparkles go away.
 - The water pump is moving water too fast through the boiler not allowing the water to pick up enough heat. Make sure it is properly sized.



2. **The combustion chamber must have a consistent slight negative pressure of 0.04" of w.c.** It should be verified with a draft gauge. A positive pressure causes flue gases to settle onto the nozzle after combustion stops (as shown in the photo at right), making a sooty mess that disrupts air from properly mixing with the fuel. A big negative pressure causes the flame to be sucked off the nozzle causing outages. Chimneys must be installed so that flue gases vent easily through the top. That allows for fresh combustion air to enter the burner end of the boiler. More "excess" air is required for combusting waste oil than clean fuel so we recommend up sizing from the chimney connector two inches.



If you have a combustion analyzer it makes adjusting the burner settings very easy. For perfect combustion we expect these readings on your analyzer: CO₂ – 12%, O₂ – 6%, CO – less than 50 ppm, excess air – 30%, chimney temperature (in clean condition) – 350°F, smoke patch results of 0 to 2.

Please review this list to see if your chimney meets these requirements:

- The chimney pipe must be sized according to the recommendations in the INOV8 Instruction Manual for the size boiler in BTUs, not according to any other source. The general sizing follows this guide: for BTUs up 275k use an 8", 300k to 600k use a 10", 650k to 1,000k use a 12".
 - The chimney should have only one 90 degree turn, typically in a Clean-out T installed on the breach before it turns upward. Horizontal runs and multiple elbows are absolutely not allowed with waste oil. That is because the ash deposits at each elbow and is a collection site for soot, which can catch fire.
 - The optimal length for the chimney is 15 feet. Taller chimneys work fine, but not shorter ones. With taller chimneys barometric dampers must be installed to dampen the effects of high winds. But it is vital that they be weighted such that it takes a strong wind to open the damper and a negative combustion chamber is maintained. Otherwise it will allow air to enter the damper rather than the burner end of the boiler. That will cause poor combustion.
 - The chimney top should be a simple inexpensive one. The fancy ones seem to restrict the free-flowing of flue gases.
 - INOV8 requires boilers to use a draft inducer to overcome the pressure drop inside the boilers. The high efficiency boilers with three pass heat exchangers create up to a 0.25" of w.c. pressure drop and that is what we strive to overcome with the draft inducer. They must be installed behind the chimney about three feet from the 'T' and wired into the control box relay. If a damper is also needed, install it before the draft inducer and properly weight the flapper door so that it takes a very strong wind to open. NEVER allow the damper door to stand open.
 - The chimney connector (where the pipe attaches to the boiler) and the chimney 'T' needs to be cleaned out at least once every heating season as ash will collect in those areas and prevent free flow of flue gases.
3. **Good oil quality** will make your experience of burning waste oil so much better. That means keeping water and dirt and debris out of the oil tank. Use an oil fill funnel that has a screen to catch large items, use the INOV8 floating pickup assembly to draw oil from the top of the oil supply, use at least one in-line filter (with a vacuum gauge to indicate when it needs to be changed), regularly check the bottom of the tank for water and drain it off, don't mix petroleum and fryer oil in the same tank, have your oil tested for BTU content and flash point when you have it checked for EPA classification. The INOV8 burner can handle most types of oil, but you may need to adjust the oil preheater higher or lower depending on the BTU content. It can range from 120,000 to 160,000 BTUs per gallon, which can mean under-firing or over-firing your boiler and/or burning the oil too cool or too hot. See above for determining the perfect pre-heat set point. With good oil maintenance, you should expect to change the filters only a couple times during the heating season.