STATEMENT OF EMISSIONS FROM INOV8 BURNERS

There are generally two concerns when using waste oil as a fuel. First, is the oil qualified to be used as a fuel (EPA Considerations), and Second has the equipment met national safety and performance standards. This document attempts to answer and dispel these concerns when using INOV8 equipment.

EPA Considerations.

The ability to use waste motor oil as fuel depends upon the characteristics of the oil and if it falls in the EPA definition of On Spec or Off Spec oil per 40 CFR, part 279 of the Federal Register. The EPA regulations allow the burning of "on-specification" used oils in equipment designed for energy recovery, generally without limitation. If the oil exceeds set limits for cadmium, chromium, lead, flash point and halogens it is defined as "off-specification" and its use is limited to 500,000 BTUs, in a vented furnace, and only by the generator.

Safety & Performance Considerations.

Oil burners are required to pass rigorous safety, construction and performance standards developed and maintained by the Underwriter's Laboratory in the United States and the Canadian Standard Association in Canada. In the U.S. the standards are UL 296 (for fuel oil) and UL296A (for waste oil) burning equipment and CSA B140.03, B140.04 and B140.2.1-M90 in Canada. Along with safety and performance tests, these standards measure stack emissions with "smoke spot tests" on each type of fuel to be used. A copy of the INOV8 results is available. Most fuels tested in INOV8 burners yielded a "zero" smoke spot test. For each of the nine fuel types tested, the results were one-half of the maximum allowable smoke spot test of a No. 4. When burning waste motor oil the results were a number 2 smoke spot which is the same as expected from residential type oil heating equipment. In general, the INOV8 burner will perform with the same cleanliness as a standard residential furnace.

In addition to satisfying third-party testing INOV8 routinely checks the efficiency of our burners with a combustion analyzer that detects levels of hydrocarbon molecules, oxygen, parts per million of carbon monoxide and carbon dioxide. It also measures excess air. These measurements combined with the temperature of the chimney allow us to determine efficiency. In a laboratory setting we are able to achieve nearly stoichiometric or complete combustion that is indicated when the excess air ratio is nearly zero. In practice we operate between 3% and 8% excess air to insure normal operations and account for on-site adjustments. When combined with a heater, the efficiency is 83% to 86%.

Chimney Emissions

There is a lot of misunderstanding of what is emitted from a chimney when burning waste motor oil. Studies have shown over the years that emissions from waste oils are very similar to that of clean fuels. Just because waste oil has a black appearance doesn't mean it emits pollutants in the burning process. The black color is carbon which actually contributes to the fuel value of the oil. Fuel oil (or diesel) contains about 140,000 BTUs per gallon. By comparison, the BTU content of waste oil is generally 150,000 BTUs due to the additional carbon content. Even when burning black waste motor oil, nothing visible goes up the chimney and a white or grey powdery ash is left behind in the combustion chamber of the heating appliance. The ash has a talcum powder consistency and is easily vacuumed to be discarded with other trash. The ash consists of the additive package in motor oil. It contains phosphate detergents for clean emissions and minerals to enhance lubrication. There is a small percentage of wear metals from the engine. In years of testing waste oil, INOV8 rarely sees oils defined as "Off-Spec" by EPA definition. Most waste motor oil generators can use their oil to heat their facilities with no government intervention or limitation.

An EPA report authored in 1984 by Robert E Hall, found that destruction removal efficiency or DRE of nearly 100% is achieved when flame temperatures range between 2000 and 2500 degrees Fahrenheit. Because the temperature of the flame on the INOV8 burner is on the low end of that range, we conclude that nearly all of the available hydrocarbon molecules are effectively destroyed and converted to usable thermal energy. In an INOV8 burner that is achieved by preheating the oil to an optimal temperature then atomizing the fuel until its tiny particles easily combust.

Below is a list of constituents present when burning any type of fuel, with the results included from an INOV8 burner.

1. CO (carbon monoxide). In common combustion of heating equipment, CO is desired to be less than 100 PPM (parts per million). INOV8 burners normally produce in the range of 20 to 30 ppm.

2. N0x (Oxides of Nitrogen) are generated at combustion temperatures above 2500^0 F (1371^0C). INOV8 flame temperatures from waste motor oil are about 2000^0 F which is well below the critical temperature.

3. SO_2 (Sulfur dioxide) waste automotive oil does not contain sulfur so does not generate sulfur dioxide, common in combustion of fuel oil. Some diesel engines may have trace amounts of sulfur in their fuel which may get in the motor oil.

4. CO_2 (Carbon Dioxide). Optimal combustion produces carbon dioxide of 13%. INOV8 burners are set to target 9 – 11% carbon dioxide. The reciprocal of this number shows up in excess air which is made available to provide complete combustion for the higher flash point motor oil.

5. O_2 (Oxygen) the INOV8 burner is generally set to provide approximately 3 to 6 % excess oxygen.

6. Dust or Ash. There are 3½ pints of unburnable residue in one 55-gallon drum of waste motor oil. For this reason, the heating appliance must have this removed periodically to maintain good heat transfer efficiency. This dry powdery ash (which is mostly mineral materials) can be discarded with other shop waste.

7. Soot – Soot is generated when there is too much fuel for available air and is present when smoke is coming out the chimney. Soot is dark in color. This can generally be corrected by adjusting fuel pressure

8. Volatile Toxic Metals – Lead has been nearly eliminated in motor oil since it was removed from gasoline and engine bearings. Other engine metals are: aluminum, chrome, copper, lead, tin, cadmium, silver, nickel, and titanium. Many of these metals are oxidized as they pass through the combustion process. If not they remain in the ash.

9. Volatile Organic Compounds. 90% of VOCs arise from plants, the remaining are man-made VOCs from chemicals like solvents, paints and protective coatings. Typical solvents are aliphatic hydrocarbons, ethyl acetate, glycol ethers and acetone. Other chemical VOCs are chlorofluorocarbons and tetrachloroethene both used in cleaning products or dry cleaning. None of the these chemicals are found in waste motor oil. The likelihood of waste engine oil generating VOCs in the process of combustion is very small and basically immeasurable.

10. PM-10 as defined is particulate matter up to 10 micrometers in size. Two categories of substances in waste oil that could contribute to PM-10 are:
    - Engine wear metals. According to Dr. Larry Nutter, professor of chemistry at the University of Wisconsin, metals that pass through a flame become oxidized and benign. They are generally too heavy to be carried up with flue gases and are collected in the ash left behind.
    - Minerals (basically clay) is added to oil to enhance its lubricity. When the oil is burned, the hydrocarbon is consumed leaving the mineral additive. The minerals make up less than 1% of the volume in oil.

11. PCDD/PCDF (Dioxins and Furans) – These are generated when chlorine or fluorine are present in the fuel. In the United States, we are not allowed to burn fuels that contain halogens or various other pre–cursers of PCDD/PCDF.

12. Moisture in the flue gas – For each gallon of fuel burned, the products of combustion contain one gallon of water in vapor form. This is not a problem when flue temperatures are 250 degrees or higher. Flue temperatures in a furnace is around 400^oF and in a boiler around 350^oF (in clean condition).

13. Volumetric Flow – The ratio of air to fuel burned is 1350 Ft^3 of 60^o F air for each gallon of fuel burned.