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Project Summary

Chemical Analysis of Waste Crankcase Oil Combustion Samples

Robert E. Hall, R.L. Barbour, and W.M. Cooke

In recent years, a dramatic increase in the price of hydrocarbon-based fuels caused an impetus for finding alternate, renewable, and recycled fuel sources. The use of waste crankcase oil for residential and industrial heating experienced a parallel increase as waste oil, available at 20 to 25 percent of the cost of distillate heating oil of equivalent thermal value, became attractive as a heating fuel. Requests from several state and federal agencies prompted EPA's Industrial Environmental Research Laboratory (Research Triangle Park, NC) to conduct a series of tests to determine the level of emissions from two types of waste oil heaters.

In addition to comparing two burner types (vaporizing pot and air atomization), EPA also investigated an automotive waste crankcase oil from a service station, and a truck crankcase oil from a diesel truck fleet.

The major concern about using waste engine oil as fuel is related to the potential for harmful emissions. The tests were designed to quantify criteria pollutant emissions such as NO_x SO_x, CO, and particulate, as well as organic and inorganic emission levels. Tests were performed on the base fuels, flue discharge gases, and residues left in the vaporizing pot heater.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Two types of waste oil heaters were tested while firing filtered, but otherwise untreated, waste crankcase oils. One was a Kroll, Model W400L, waste oil heater rated at 35.2 kW (120,000 Btu/hr heat input). It uses a vaporizing pot burner in which only the heated vaporized fuel is combusted. With this type of burner the residue of unburned material, which accumulates in the bottom of the fuel pot, must be physically removed. This residue was also analyzed for organic and inorganic content.

The other unit tested, a Dravo Hastings Thermoflo, Model 20-WO, waste oil heater rated at 73.3 kW (250,000 Btu/hr heat input), uses a low-pressure air atomizing burner. With this type of burner most of the fuel is burned and discharged as stack effluent. Tests were performed at EPA's Research Triangle Park test facility.

Emissions from the two waste-oil-fired space heaters were sampled by EPA personnel and analyzed by Battelle-Columbus personnel using EPA Level 1 procedures. In addition to Level 1 procedures, fuel characterization tests and advanced metals analysis using inductively coupled argon plasma spectrometry (ICAP) were performed.

The combustion of both truck and automotive crankcase oils was examined in each heater, resulting in four test runs. During each run, the stack was sampled by two different techniques (the Source Assessment Sampling System (SASS) train and a dilution tunnel), producing eight sets of sampling data. The following analyses were performed:

(1) Level 1 analysis of four SASS trains, four sets of dilution filters, and two samples of pot residue.

(2) Determination of heating value, moisture, ash, viscosity, and C, H, N, S analysis of the two waste oils.

(3) Inductively coupled argon plasma (ICAP) analysis for 28 elements on 20 combustion samples and two waste oils.

Results

Three basic comparisons were performed in this study: burner type, fuel, and method of sample collection. Figure 1 shows the two generic combustor types: air atomization and vaporizing pot. Both heaters are designed to operate on waste engine oil. The different oil induction systems result in differences in the kinds and amounts of samples recovered from the units. The vaporizing pot heater produced both flue gas and a pot residue, whereas the air atomizing heater produced only flue gas.

In both combustion systems the time-weighted average Threshold Limit Values (TLVs) were exceeded for several elemental species. No firm risk conclusions can be drawn directly from the results of this project. Stack concentrations were sampled, not ground level ambient concentrations. Although the dilution tunnel theoretically simulates natural dispersion and dilution, it is not certain at this time whether the tunnel accurately simulate air circulation in and around a servic station or garage work place, where thes heaters are commonly used.

Table 1 shows the measured flue dis charge concentrations for metallic specie and compares them to the 8-hour TLV fo each element. The air atomizing burne yielded higher gas-phase concentration of most inorganic species than the vaporiz ing pot combustion system. Table 1 illustrates this trend for metals.

Two fuel types were compared in thi study: an automotive waste crankcase oi and a truck crankcase oil from a diese truck fleet. Fuel comparisons revealec generally higher concentrations of metallic species in the automotive oil. Total organic concentrations were similar for the twc fuels, although chemical composition o the organic discharges was different.

Metal concentrations in the flue gases were generally higher for automotive fue than for truck fleet crankcase oil. This effect is illustrated in Figure 2, where gaseous discharges are compared to fuel concentrations on a per-gram-of-fuel-burned basis.

The sampling comparison was made between the two methods used to collect gaseous emissions. One technique, the Source Assessment Sampling System (SASS), provides information about the size distribution of particulate discharges in burner outlet gas streams. The SASS sampler is also efficient for trapping gaseous discharges, principally organic material, which is collected by sorption on a resin bed. The second sample collection system, a dilution tunnel, employs a clean air dilution stream followed by filtration. By diluting the hot discharge gases before a sample is collected, the dilution tunnel theoretically simulates the natural dilution and chemical transformation that occurs

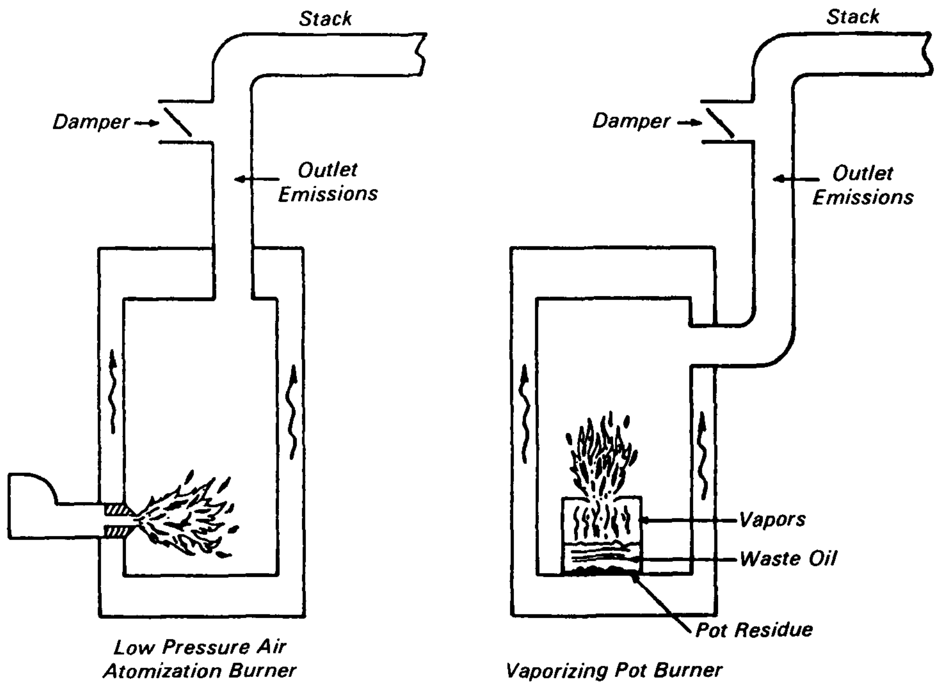

Figure 1. *Low-pressure atomizing and vaporizing pot combustion principles.*

Table 1. *Comparison of Discharge Concentrations of Some Elements Determined by ICAP and the American Conference of Governmental Industrial Hygienists Threshold Limit Values (all values in $\mu g/m^3$)*

Element	*Pb*	*P*	*Cr*	*Ni*	*Cu*	*Zn*	*Cd*	*Fe*	*Co*
Threshold Limit Values (Time-Weighted Averages)	150	1000	500	100	1000	5000	50	1000	50
SASS Trains									
Vaporizing Burner-Truck	197	205	1547	1104	16	450	-	5,641	21
Vaporizing Burner-Automotive	1,604	199	4198	21	16	194	1	15,180	54
Air-Atomizing Burner-Automotive	143,900	19,440	4954	3548	2377	66,210	109	22,280	72
Air-Atomizing Burner-Truck	57,740	68,710	313	1560	2377	117,400	155	15,510	23
Dilution Filters									
Vaporizing Burner-Truck	124	522	0.9	4	11	341	0.3	48	2
Vaporizing Burner-Automotive	549	170	0.6	-	6	89	0.4	37	1
Air-Atomizing Burner-Automotive	85,800	40,460	295	54	1764	45,650	86	9,041	218
Air-Atomizing Burner-Truck	23,770	50,760	79	32	1019	44,630	86	4,374	9

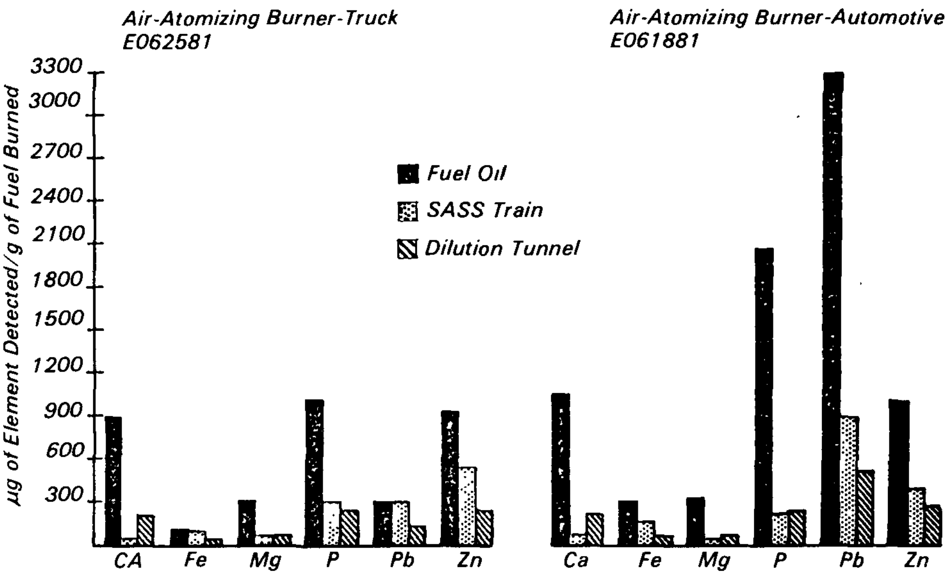

Figure 2. *Comparison of total mass of elements determined by ICAP for fuel oil, SASS train and dilution tunnel for the air-atomizing heater burning automotive and truck crankcase oil (E062581 and E061881).*

when stack gases are discharged to the atmosphere. As Figure 2 shows, the SASS train collected larger amounts of the elemental discharges than the dilution tunnel in most cases. The effect was also observed in organic emissions. The SASS train incorporates a cooled resin bed positioned after the heated filter. The resin bed is effective in collecting organic constituents, especially semivolatile compounds that may not be retained on the dilution tunnel filter.

Conclusions

The following conclusions can be summarized from this study.

Burner Type — Air-Atomization and Vaporizing Pot

- The air-atomizing heater, which atomizes the fuel before combustion, does not produce a pot residue. The vaporizing pot heater, which burns heated oil vapor, produces a dense pot residue. The air-atomizing heater releases much higher concentrations of metals into the air than does the vaporizing pot heater. This trend is also followed by the organics.
- The vaporizing pot heater also showed significant quantities of organic material in the pot residue.
- There was evidence of polynuclear aromatic hydrocarbons (PAHs) in both types of combustion systems.

Sample Collection Method — Dilution Tunnel and Source Assessment Sampling System

- The dilution tunnel collected generally less organic material than the SASS train. Three of the four tests showed 20-30 percent lower organic concentration when sampled by dilution tunnel.
- The SASS train generally collected a higher percentage of the metals present in the fuel than the dilution tunnel collected.

Fuel — Automotive and Diesel Truck Fleet Waste Crankcase Oil

- Ultimate analysis of the two fuels indicated a higher oxygen content in the automotive crankcase oil
- The automotive crankcase oil contained higher concentrations of metals than the truck derived fuel. This was reflected in the effluents, as well as by fuel analysis.

R. L. Barbour and W. M. Cooke are with Battelle-Columbus Laboratories, Columbus, OH 43201.
***Robert E. Hall** is the EPA Project Officer (see below).*
The complete report, entitled "Chemical Analysis of Waste Crankcase Oil Combustion Samples," (Order No. PB 83-209 882; Cost: $23.50, subject tc change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Industrial Environmental Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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Center for Environmental Research
Information
Cincinnati OH 45268