



Emission and Residue Characteristics from Burning Artificial Wax Firelogs

Victor S. Li, Environment Canada, Environmental Protection Operations Division - Ontario,
4905 Dufferin Street, Toronto, Ontario, Canada, M3H 5T4

Associate author: Mr. Steven Rosenthal, US EPA, Region 5, Air and Radiation Division,
77 West Jackson Boulevard, AR-18J, Chicago, Illinois, USA 60604-3590



Abstract:

Information found regarding these products was outdated with very few independent studies measuring the emissions. Environment Canada (Ontario) and the USEPA (Region 5) collaborated in this study to analyze the contents of 5 types of wax firelogs and measure their emission characteristics. OMNI Labs was contracted to conduct the study, under the direction of Dr. James Houck. Logs tested in this study were manufactured by Duraflame, Conros and Robustion Technologies.

The emission data indicated that the levels of particulate and chemicals such as polycyclic aromatic hydrocarbons (PAHs) are less than burning with cordwood. The residue content for metals such as aluminum, barium, calcium, copper, magnesium, manganese, potassium and sodium varied significantly from log to log.

This paper will describe the burning characteristics and emissions created from these logs and provide an update of the contents which can be expected when using these products.

Sampling and Test Methods:

Air Emissions

Pollutant samples were collected from a dilution tunnel and analyzed following standard sampling and analytical methods.

Particulate samples were collected isokinetically onto Gelman type A/E filters and were the sum of the mass of material collected on the filter and the material removed from the filter holder and buttonhook nozzle with an acetone rinse. All filters were desiccated to constant weights before and after sampling.

The carbon monoxide testing was done separately from the other testing on a second set of tests due to difficulties with the carbon monoxide analyzer encountered during the first set of tests. Volatile organic compounds (VOCs) were measured with a flame ionization detector analyzer following EPA Method 25A.

Nitrogen oxides (NOx) concentrations were measured with a chemiluminescent gas analyzer by EPA Method 6C. All gas analyzers were calibrated with EPA Protocol 1 certified gas standards.

Log Composition

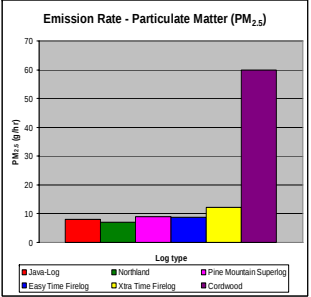
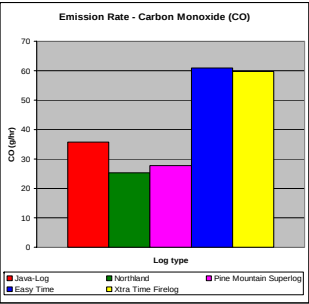
Metals were analyzed in the residue by EPA Method 6010 except for mercury which was analyzed by EPA Method 7471.

The heat content (higher heating value, HHV), as well as, moisture, ash, carbon, hydrogen, oxygen, nitrogen, and sulfur contents of both the firelogs and their combustion residues were determined by proximate/ultimate analyses.

Wax content was determined gravimetrically by weighing the fiber and wax separately after multiple hexane extractions to separate the fiber and the wax. After separation, the wood fiber was sent to the USDA Forest Services' Forest Products Laboratory for tree species identification and the wax was characterized by measuring the percent oil (ASTM Standard D721), carbon count (ASTM Standard D5442), and by needle penetration (ASTM Standard D1321).

Residue Analysis							
Analysis	Units	Robustion Technologies Java-Log	Conros Northland	Conros Pine Mountain Superlog	Duraflame Easy Time Firelog	Duraflame Xtra Time Firelog	Mean
Aluminum	mg/kg residue, dry	6210	3220	6170	3860	2550	4402
Barium	mg/kg residue, dry	338	412	521	1530	469	654
Boron	mg/kg residue, dry	48	90	100	122	97	91.4
Calcium	mg/kg residue, dry	120,000	46,500	70,600	35,300	26,300	59,740
Chromium	mg/kg residue, dry	31	147	21	60	14	54.6
Copper	mg/kg residue, dry	2190	524	70	274	201	652
Lead	mg/kg residue, dry	<20	23	23	25	28	21.8
Magnesium	mg/kg residue, dry	12,900	7700	7090	5830	3750	7454
Manganese	mg/kg residue, dry	2470	1170	2790	1410	727	1713
Mercury	mg/kg residue, dry	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Nickel	mg/kg residue, dry	124	34	29	20	2730	587
Phosphorus	mg/kg residue, dry	8630	1820	2160	3190	2520	3664
Potassium	mg/kg residue, dry	49,000	60,900	43,600	23,600	33,300	42080
Sodium	mg/kg residue, dry	6710	5350	16,000	9220	5330	8552
Vanadium	mg/kg residue, dry	12	8.3	5.7	5.6	74	21
Zinc	mg/kg residue, dry	1410	201	400	283	151	489
Chloride	mg/kg residue, dry	95	708	153	43	136	227
Ash*	% dry basis	50	37	25	39	24	35

*Ash here refers to inorganic compounds left after complete, high-temperature combustion in the laboratory.



Conclusions: All five of the firelogs lit easily and had visible flames for approximately the burning time indicated on the packaging. Beside the understandable health and environmental interest in air emissions, the chemical makeup of combustion residue was measured due to concern over the incidental ingestion of combustion residue (bottom ash) and the common practice of land application of residential wood combustion ash for use as a soil amendment.

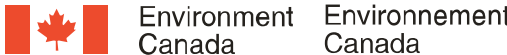
The overall emission reduction from these logs is consistent with previous studies. Therefore, the amount of emissions created during the burning period was confirmed in this study.

It was very interesting to see the variation in the composition and amount of emissions created from these logs. The Emission Rates indicated that the Duraflame Easy Time and Xtra Time products produced about twice as much carbon monoxide as the Conros Northland and Pine Mountain products. The Residue Analysis Table, provide some interesting information about the content of these logs after burning has been completed. The amount of aluminum varies quite significantly from log to log, the same goes for other metals such as barium, copper, magnesium and manganese. Other chemicals such as calcium, potassium and sodium show similar variations.

The emissions of benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs), which are Level 1 and 2 substances under the Great Lakes Binational Toxics Strategy, were generally not detected or at low levels. Naphthalene, phenanthrene, acenaphthalene and fluorene were generally detected in the emissions. However, emission rates for almost all measured PAHs were below 10 mg/hr (naphthalene had emissions in the 17-42 mg/hr range).

There are two main components composing these logs, wood fiber and wax. The wood fiber generally consists of cellulose and wood resins act as the glue to hold the cellulose together. Historically, the wax used was a derivative of the petroleum industry. It was a paraffin wax. However, as was explained in the Results section of this report, some manufacturers use other products instead of paraffin wax to provide the same purpose.

This paper does not discuss the health issues regarding the amount of metals or chemicals in the residue as the limits vary from province to province and state to state. Any comments would only confuse the reader. The information provided in this paper can be checked individually and compared to local regulatory requirements to address individual concerns regarding health. The application which seems to be popular with this kind of residue is soil enhancement for gardens. Consumption of vegetables from such gardens could be a pathway to measure the impacts of ingestion of these compounds.



Study
Sponsors



Products
tested

