

Addendum to: Recommended Procedure for Compiling Emission Inventory Data for Manufactured Wax/Sawdust Fireplace Logs

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Introduction

A memorandum entitled, "Recommended Procedure for Compiling Emission Inventory Data for Manufactured Wax/Sawdust Fireplace Logs," has been submitted to the U.S. EPA. The purpose of that memorandum was to provide activity data for wax/sawdust fireplace logs and to allow for the adjustment (reduction) in the estimated activity of cordwood in fireplaces due to wax/sawdust fireplace log use. In addition, PM₁₀ emission factors were provided for wax/sawdust fireplace logs to permit their PM₁₀ emissions to be calculated. Example calculations for the 1997 base year were also provided. These calculations showed the reduction in PM₁₀ by replacing cordwood usage with wax/sawdust fireplace logs.

A key point relevant to both the earlier memorandum and this addendum to it, is the fact that emission factors on a mass of pollutant per mass dry fuel basis are not directly comparable between cordwood and wax/sawdust fireplace logs. This is because the heat content of wax/sawdust fireplace logs is nearly twice that for cordwood and wax/sawdust fireplace logs are designed for one-at-a-time usage whereas the average cordwood burn rate in a typical fireplace is about 4.0 dry kg/hr. The calculation of the mass equivalency for usage of wax/sawdust fireplace logs as compared to cordwood was conducted in the original memorandum. The calculation showed that one dry kilogram of wax/sawdust fireplace logs replaced on the average 4.49 dry kilograms of cordwood.

At the request of Eastern Research Group, other updated emission factors for both cordwood and wax/sawdust fireplace logs burned in fireplaces have been provided in this addendum. These factors are for carbon monoxide, formaldehyde, benzene, 16-PAH and 7-PAH. The testing procedures used

to develop the emission factors are described in references 15,16, and 21 of the original memorandum and references 1 and 2 here. Not only are the emission factors for wax/sawdust fireplace logs of interest, but values for several of the fireplace cordwood emission factors are also useful, in that few, if any, direct measurements have been made for them. These include formaldehyde, benzene, and 16-PAH. Emissions of pollutants from cordwood were made in the same study as fireplace logs tests to provide baseline information for comparison purposes as there is a paucity of data for emissions from cordwood burned in fireplaces.

Emission Factors

Emission factors for various air pollutants from representative wax/sawdust fireplace log and cordwood tests, as well as CO and PM (assumed to be the same as PM_{10}) from a literature review of fireplaces (which was published in reference 21 of the original memorandum), and CO and PM_{10} from AP-42 are compiled here. The emission factors for particles (PM, PM_{10} , and $PM_{2.5}$), carbon monoxide (CO), formaldehyde, benzene and polycyclic organic material (POM) are shown in Tables 1 and 2. The standard 16-PAH and 7-PAH surrogates for POM are shown in the tables. Table 1 gives the emission factors in the units of g/dry kg. Table 2 gives the emission factors in the units of lbs./dry ton. It is the authors understanding that the emission factors for PM (assumed to be the same as PM_{10}) and CO based on the literature review of fireplaces(reference 21 of the original memorandum) will be used in the emission inventory. It should be noted that the emission factors based on the literature review for PM_{10} (actually PM) and CO compare favorably with the emission factors derived from the representative cordwood tests done to collect baseline data for the fireplace log study. It should also be noted that the measured values for PM, PM_{10} and $PM_{2.5}$ are all within the uncertainties of the measurement techniques of each other. This is because the overwhelming majority of particles emitted from both cordwood and wax/sawdust fireplace logs are submicron in size, although repeated tests with wax/sawdust fireplace logs have shown that a slightly larger fraction of particles emitted from them are larger than 2.5 microns than for cordwood burned in fireplaces. The AP-42 values for CO and PM_{10} for cordwood burned in fireplaces (shown for completeness in Tables 1 and 2) are significantly larger than the values derived from the literature survey and from actual measurements of representative fireplace usage. The emissions of all seven polycyclic aromatic hydrocarbons making up the 7-PAH category were below detection limits and the difference in the two “less than” values reflect the differences in volumes and fuel masses used in the tests and do not reflect any actual differences in emission factors.

Table 1
Emission Factors for a Representative Fireplace Burning Cordwood and Wax/Sawdust Fireplace Logs
(g/dry kg)

data base	PM	PM ₁₀	PM _{2.5}	CO	Formaldehyde	Benzene	16-PAH	7-PAH
cord-wood	14.7	14.9	15.4	80	1.59	0.891	0.182	<0.001*
wax/sawdust log	28.6	25.9	27.0	97	1.40	1.44	0.114	<0.05*
fire-place distribution data	11.8			64.1				
AP-42		17.3		126				

* Detection limits

Table 2
Emission Factors for a Representative Fireplace Burning Cordwood and Wax/Sawdust Fireplace Logs
(lb/dry ton)

data base	PM	PM ₁₀	PM _{2.5}	CO	Formaldehyde	Benzene	16-PAH	7-PAH
cord-wood	29.4	29.8	30.8	160	3.18	1.782	0.364	<0.002*
wax/sawdust log	57.2	51.8	54.0	194	2.80	2.88	0.228	<0.1*
fire-place distribution data	23.6			128.2				
AP-42		34.6		252				

* Detection limits

Emission Reductions

Table 3 lists the reduction of air pollutants for each ton of cordwood replaced by wax/sawdust fireplace logs. Based on the analysis of cordwood equivalency, one ton of dry cordwood would be replaced by 445 lbs. of wax/sawdust fireplace logs. As can be seen in Table 3, significant reduction in the air pollutants occur when cordwood is replaced by wax/sawdust fireplace logs. No calculations were done for the 7-PAH category since the values would be meaningless due to the fact that all seven compounds making up the category were below analytical detection limits and the overall difference in detection limits between cordwood versus wax/sawdust fireplace logs is due to differences in the volume of aerosol sampled and the mass of fuel burned. Because there were three different emission factor sources for cordwood PM₁₀ and CO, the emission reductions for replacing cordwood with wax/sawdust fireplace logs as shown in Table 3 were calculated three ways.

Table 3
Emission Reductions by Replacing One Ton of Cordwood with Wax/Sawdust Fireplace Logs

Pollutant	Mass of Reduction (lbs.)
PM ₁₀ (representative tests)	18.3
PM ₁₀ (literature survey)	12.1
PM ₁₀ (AP-42)	23.1
CO (representative tests)	117
CO (literature survey)	85
CO (AP-42)	209
Formaldehyde	2.56
Benzene	1.14
16-PAH	0.313

Additional References

1. Houck, J.E., and Scott, A.T., March 31, 1999, Duraflame Emissions Benefits Study, Summary, Analysis and Original Data, Omni Environmental Services, Inc. report to Duraflame, Inc., Stockton, CA.
2. Houck, J.E., and Scott, A.T., July 29, 1999, Duraflame Emissions Benefits Study, Results of Two Supplemental Tests, Omni Environmental Services, Inc. report to Duraflame, Inc., Stockton, CA.