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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Emission factors for PM_{10} and PAHs from illegal burning of different types of municipal waste in households" *by* András Hoffer et al.

Anonymous Referee #2

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In this work, the authors studied the emissions of particulate matter from combustion of materials commonly used in household products. They burned a variety of different plastic and wood materials under controlled conditions, and reported emission factors of PM10 and PAHs. They found these plastic materials have a much higher EF of PM10 and PAHs, and based on the profile of PAHs measured, their potential toxicity as indicated by benzopyrene equivalence is significantly higher. These results are very interesting and relevant to the scope of ACP. The topic is particularly novel, since, to my surprise, there are not many measurements of this type. My overall evaluation of this manuscript is that it can benefit from more discussion of context and significance, because I believe this work is potentially impactful. The changes I recommend are

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Discussion paper

fairly major, but does not involve additional experimental work, so I believe that this manuscript should be accepted with these major modifications.

Major comments:

In general, I find that there is insufficient context to the discussion. The manuscript still leaves open the question of importance, which I am sure any reader would ask. The only quantitative evidence I can find in the manuscript is a survey of Hungary, which found that 2-10% of participants are engaged in some sort of household waste combustion activity. So how much is there? All the results here are reported in emission factor ("emission" per "mass burned"), but there are virtually no data on "mass burned". Even an order of magnitude or a relative estimate would be useful. For example, for an average household who burn household waste, what is the ratio of mass of wood burned to mass of plastic burned?

I am also curious why plastic materials yield much higher PM and PAHs than wood materials. Is the composition of the material itself, or the mechanism of combustion? Both are organic polymers, but the size of the macromolecules may be different. Wood is generally made up of carbon, hydrogen and oxygen, where in plastics and rubber, nitrogen and chlorine are also present. The PM emissions seem to be somewhat linearly additive, as evidenced by the emission factors of RAG (a mixture of PET and wood) to be in between PET and wood.

This manuscript also makes no mention of all the other toxic compounds that are known to be emitted from plastic burning. Two of the most studied ones are dioxins and furans. There may also be a lot of metals involved, such as from tyre materials. That is an important body of knowledge that is highly relevant to this discussion.

I would also note that the introduction, results and discussions are focused on the "illegal" burning of waste, but I am not sure why this aspect is important. What is it about "illegal" burning that needs special treatment? (It is even in the title.) To me, this is just combustion of different materials, and some materials yield much more

PAHs and PM than others. Are “illegal” combustion conditions any different? If so, it might be useful to highlight. This issue is not just one of semantics – it is important for understanding the context of these results too. These emission factors may also apply to “legal” waste combustion, such as incineration facilities. For example, the high emission factors from plastics may provide additional incentives to separate them from other waste prior to incineration. Another potential area of concern is the increasing prevalence of wildland-urban interface fires. More manmade materials and household items would be burned in these fires, and these results have potential implications on the PM emissions and toxicity. My opinion is that the manuscript in its current form does not draw any connections to many other relevant areas.

There are also some major questions about the methods:

First is that based on the pictures in Figure 1, the materials appear to be prepared such that they are all roughly the same size. How does the material preparation affect the emissions? Would large pieces combust differently and emit different amounts of pollutants?

Second, how are the emissions normalized to calculate EFs? What is the mass for normalization? Is it the mass of materials put into the stove, or the mass loss from combustion?

Third, what is done about positive and negative artifacts for sampling semivolailte organic compounds and PAHs on quartz filters?

How are the experiments repeated? I see there are uncertainty bars (and S.D.) reported in the figures. Are they replicate samples, or samples from different burns?

Other comments

Title: the choice of the word “illegal” is questionable here. At first I thought this was a field study, sampling actual illegal combustion in households. Rather this work is done in a highly controlled environment. Therefore I find the title misleading and inaccurate.

Abstract: The abstract should mention more of the results and significance of this work. In this work, the major finding is that EF of PM10 and PAHs for plastics are much higher than expected, and toxicity equivalent factor is much higher. There are also some unsubstantiated claims about waste burning ("unprecedented health hazards") that should be moderated.

Abstract: the synonym EF is defined here but not used again in the abstract.

Introduction: There are instances where the background discussions reflect a Eurocentric bias and invoke negative stereotypes. For example, the first sentence mentions "In developing countries, more than three billion people use solid fuels. . .". The fact that developing countries are burning solid fuels is irrelevant to this work and mentioning "developing countries" is unnecessary, since this work seems to focus on illegal waste burning in European countries. Futhermore in a later paragraph, ". . .the illegal burning of municipal solid waste in households in several countries of the world, even in Europe". The way this sentence is constructed reflects an assumption that illegal activities are not expected in Europe and perpetuates a stereotype. I urge the authors to use more inclusive language and consider more diverse perspectives in their writing.

Page 2, lines 58-59: these papers should be cited, since they represent the state of knowledge on this topic.

Page 2, lines 65: again, references for the toxicity of these compounds should be cited.

Page 3, line 109: what does high/low air supply ratio mean? This is qualitative and not really explained.

Page 3, line 119: how much of the CO2 comes from the background smouldering of coal?

Page 5, line 190: what does significantly higher nominal power mean? Why is that relevant to emission factor? It might be more direct to say how the combustion conditions differ. Also, I believe "though" should be "through", but I am not sure.

Page 6, line 196: tyres contain a lot of metals and their emissions are potentially toxic too. This paper examines PM and PAHs, but metals and organic compounds could be redox active and cause oxidative stress. This may be a good topic for discussion in the conclusions section.

Page 6, Line 200: ABS is very interesting. Since acetonitrile is involved, there may potentially be nitrogen-containing compounds in the PM as well. Again, there is lack of discussion of why the PM emission factors (and PAH toxicity equivalents) are so different, and no attempts to examine the link between PM/PAH and the fuel itself.

Page 6, Line 208: lower case “rag” was used here, but upper case “RAG” was used earlier.

Page 6, line 232: What does “reactive share of PAHs” mean? It is not clear what reactivity the authors are referring to.

Page 7, lines 236-261: I wonder if the difference has to do with volatility. What do the volatility distribution of PAH look like between the samples? Is it because in general plastics produce “heavier” PAHs, and the other samples generate “lighter” PAHs? (I understand the toxicity discussion and it is very important, but I am looking for some more information that would tell us how these PAHs are generated.)

Conclusions: I don’t really see the point of repeating all the numbers if they are already shown in the table and in the figures.

Figure 2: what does O2 rise and CO2 drop at some times? Is this when the combustion chamber is open to place the sample?

I don’t really see why it is necessary to have both a table and a figure showing essentially the same data. (Table 1 and Figure 3, Table 2 and Figure 4)

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