Li et al. present the evaluation of a custom ECCC-OFR design by performing characterization studies that included measurements of size-dependent particle transmission efficiency and yields of SOA generated from OH oxidation of α-pinene and C7, C10, and C12 n-alkanes in the presence and absence of ammonium sulfate seeds. Results are compared to those obtained with other OFRs and environmental chambers. Unlike in previous OFR studies, alkane-generated SOA did not exhibit a decrease in yield at high OH exposure due to fragmentation reactions. The ECCC-OFR is then used to investigate the SOA formation potential following OH oxidation of materials obtained from oil sands operations in Alberta. Cyclic alkanes are implicated as the most important class of precursors in the oil sands samples. Overall, the manuscript reads well. Given the emergence of OFRs as a technique to characterize SOA formation, and the application of the ECCC-OFR to study the aging of environmentally-relevant VOC mixtures that are emitted during oil sands extraction activities, I would support eventual publication of this manuscript in ACP. However, in its current form, I have reservations about assumptions that are made regarding laminar flow behavior, reduced wall losses compared to other OFRs, and SOA yield calculations that are heavily reliant on offline measurements of SOA precursor concentrations. In my opinion these assumptions are not adequately justified based on the current information that is given, and any related conclusions made about ECCC-OFR performance compared to other OFRs are uncertain at present.

General Comments

1. Recent OFR applications and modeling studies have demonstrated the utility of 185 nm radiation in OFRs due to ease of use in the field and due to additional HO_x generation via $H_2O + h\nu(185) \rightarrow H + OH$, $H + O_2 \rightarrow HO_2$. Here, the authors specifically mention that they chose to use mercury lamps that exclude the 185 nm emission line. Please explain the reasons for this choice.

2. The actinic flux at 254 nm is an important OFR characteristic that, unless I missed it, was never measured or calculated. It would be worthwhile to calculate this value and compare to the other OFR designs that are mentioned. For example, a possibility that is never discussed is whether potential SOA photolysis at 254 nm (which is more potentially important at high UV intensity and OH exposure) might be less important in the ECCC-OFR than in the PAM OFR due to lower actinic flux. I am not necessarily convinced that this is the case, but it should be briefly discussed and ruled out if not applicable. The preferable method to quantify the actinic flux would be to photolyze a compound with known absorption cross section at 254 nm as a function of lamp voltage. At the least, I think the maximum actinic flux inside the ECCC-OFR could be estimated from the wattage of the UV lamps at full output normalized by the internal surface area, with the caveat that I am not to what extent the mirrored enclosure referred to on P4, L14-15 would influence this calculation.

3. In the ECCC-OFR, the authors state that an inlet with a cone angle of 30^o is used to "minimize the establishment of jetting and recirculation in the OFR", which is steeper than the 15^o cone angle used by Huang et al. (2017) and the 14^o cone angle used by Ihalainen et al. (2019). Whereas both of those studies employed CFD simulations to optimize their OFR design, there are no corresponding simulations of the ECCC-OFR fluid dynamics that support the 30^o cone angle used here. Please provide supporting calculations and/or residence time distribution measurements supporting the claim that laminar flow is achieved and jetting/recirculation is not present when using a 30^o cone angle.

4. The authors hypothesize that wall interactions are minor in the ECCC-OFR based on a calculation of the diffusion timescale (1400 sec) that is much longer than the residence time (120 sec) (P7, L1-8). Applying the same calculation to the PAM OFR, which has an inner radius of 10.2 cm, yields a diffusion timescale of 1474 sec. Given similar residence times and diffusion timescales, this line of reasoning would suggest similar wall interactions between the two systems. However, large-scale dispersion and recirculation inside OFRs (e.g. Lambe et al., 2011; Huang et al., 2017) complicates this sort of simple diffusion-based calculation. Later on (P9, L6-7), the authors speculate that higher SOA yields and less fragmentation are observed in the ECCC-OFR because of reduced wall interactions compared to other OFRs. This might be the case, but it is not supported by the logic presented above. This conclusion should be supported with a corresponding residence time distribution measurement and comparison to the RTD expected for ideal laminar flow, which was not performed here (P7, L9). In my opinion this is a critical oversight that should be addressed. Additionally, I suggest measuring the yield of sulfuric acid generated from OH oxidation of SO_2 and comparing the result to other OFRs. Because sulfuric acid is not affected by photolysis or fragmentation, any difference in sulfuric acid yields between OFRs should be directly related to wall losses/interactions.

Specific/Technical Comments

5. **P4, L16**: Please specify the O_3 mixing ratio (or range of O_3 mixing ratios) that was added to the OFR in these studies.

6. **P5, L5-7**: Because precursor concentrations were only obtained in offline measurements, how did the authors determine that the precursor concentrations remained constant and precise during the OFR experiments? As written, in the absence of other supporting/independent measurements this seems to be a major assumption and potential source of uncertainty in the SOA yield calculations.

7. **Figure 1 and Section 3.1.1.**: The Lambe et al. 2011 reference used a Pyrex chamber, where wall losses of charged particles are higher than chambers made of conductive materials due to charge buildup on nonconductive surfaces. A better reference/comparison here would be to use the data from Figure S1 of Karjaranen et al. (2016) which used an aluminum chamber with conductive coating. Their particle transmission data is shown below for reference. Please modify the discussion and figure accordingly.

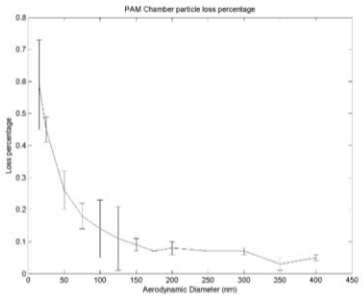

Figure S1. Primary particle losses in a similar PAM chamber that was used in the study.

8. **P15, L7**: The authors state: "all future OFR experiments should be conducted with seed particles to obtain more relevant qualitative and quantitative data." I suggest making this statement in the specific context of laboratory SOA yield studies, as not all OFR experiments are intended to measure SOA yields and because addition of seed particles in ambient OFR experiments is not necessarily always desirable or practical.

9. **P11, L30 and Figure 4c**: Lambe et al. (2012) do not report absolute SOA yields from OH oxidation of diesel fuel and crude oil so it is unclear where this statement originates from.

10. **Figure 1**: It may be worth adding particle transmission data from Ihalainen et al. (2019) to this figure. Also, how much passivation time is required to obtain 100% transmission efficiency of C7, C10 and C12 alkanes, and at what mixing ratios are they introduced to the ECCC-OFR?

11. **Figure 3**: I think this could be moved to the Supplement.

12. **Figures 4-6 and related text**: I suggest a reorganization to improve clarity and flow. First, move the current Figure 5 to the Supplement or to Methods. Second, combine the current Figure 6a with the current Figures 4a and 4b into a single 3-panel figure. Third, move the current Figure 4d into a separate figure and place between current Figures 4 and 6.

References

M. Ihalainen, P. Tiitta, H. Czech, P. Yli-Pirilä, A. Hartikainen, M. Kortelainen, J. Tissari, B. Stengel, M. Sklorz, H. Suhonen, H. Lamberg, A. Leskinen, A. Kiendler-Scharr, H. Harndorf, R. Zimmermann, J. Jokiniemi, and O. Sippula (2019) A novel high-volume Photochemical Emission Aging flow tube Reactor (PEAR), Aerosol Science and Technology, 53:3, 276-294, DOI: 10.1080/02786826.2018.1559918.

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