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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterization and testing of a new environmental chamber designed for emission aging studies" *by* A. Leskinen et al.

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General Comments:

This paper describes the design and initial testing of a new environmental chamber for studies of atmospheric particle formation and transformation. Although it does not present any new scientific results, it may be appropriate for this journal because a chamber can be considered an important measurement tool, and its characteristics can affect all measurements made from experiments in the chamber. Therefore, if the paper described a chamber that is well designed for its intended purpose and provided all (or at least most) needed characterization data, then I think its publication in this journal would be appropriate.

This paper is clearly written and gives a good description of how the chamber is designed and some of its characterization data. I have two main problems with this paper; one concerning the nature of the light source employed (i.e., the design of the chamber), and the other concerning the lack of important characterization data. These and other problems are discussed below.

Specific Comments:

This chamber is similar in many design characteristics as that described by Carter et al (2005). Although that reference is cited in the "methods" section, it should also be cited in the introduction when they list environmental chambers with different designs. It is now extensively being used by Cocker and co-workers for SOA studies, some of which are cited in this manuscript. My comments on this paper are based in part on my experience with design and use of the chamber described by Carter et al (2005)

The spectrum of the light source in this chamber is given in Figure 4 of the manuscript. It shows no intensity in the UV region from 300 to about 340 nm. Although this spectrum is sufficient for photolyzing NO2, it will result in abnormally low photolysis rates relative to atmospheric for other photolyses that are potentially important radical sources, such as photolysis of O3 forming O1D (which might be important in their "cleaning" process) and photolysis of aldehydes and other photoreactive compounds whose action spectra decrease rapidly near the 300 nm cutoff for ground-level sunlight. Although light sources should not have significant intensity below the 300 nm cutoff, it is important that they have a spectrum similar to sunlight in the important 300-400 nm region.

Figure 2 in Carter et al (2005) shows the spectrum of the type of blacklights usually used in environmental chambers with blacklight light sources. This is the type they should have used in this chamber. If this is not feasible because of safety regulations, they need to include a discussion of the problems with these lights with regard to some potentially important photolysis process, and a justification as to why it is sufficient to consider only NO2 or HONO photolysis for their purposes. People reading this paper

to study how to design their own chambers need to know the limitations of this type of light source.

Since a major objective of use of this chamber is to study PM formation in the chamber, they need to provide information on background PM formation. As discussed by Carter et al (2005), conducting pure air or propene - NOx irradiations and measuring particle formation provides a very useful and sensitive test of background particle formation. These experiments should involve no particle formation, and if particles are observed they are likely due to contamination. They found that particles formed in such irradiations with new reactors were very high but declined over time, but that the results are variable and relatively high levels are observed from time to time, presumably due to wall offgasing of contaminants whose reactions form particles. It is not due to offgasing of particles themselves, at least in the chamber of Carter et al (2005), because there is no PM formation in the lack of added SOA precursors in experiments where added NOx or CO suppress OH radicals.

Because of the importance of background PM and the results of the characterization of the Carter et al (2005) chamber, this paper is not acceptable for publication until at least pure air and/or propene - irradiations are carried out and the results described. (Simply because other groups have published papers on PM formation in chamber experiments without conducting or reporting these important background characterization tests, it does not mean it is scientifically acceptable.) If particle formation is observed, they should conduct CO - air or CO - NOx experiments to see if it is due to particle or particle precursor contamination. Carter et al (2005) also describe characterization of NOx or HONO offgasing or other background effects, though they not be as important as background PM for the types of experiments to be conducted in this chamber. Nevertheless, it would be good if they could report these types of characterization results as well, or at least mention that NOx or HONO offgasing is also observed in chambers and should be characterized if experiments are to be conducted that would be affected by this.

More explanation is needed as to why photolyzing highly humidified air with O3 present was chosen as the method to "clean" the chamber. Ideally there should also be data showing that it indeed cleans a contaminated chamber – though they would need to do experiments like pure air irradiations to assess the level of contamination, and if the results are always negative they won't be able to show that it works. The high level of humidity may give a concern about water condensing on the walls, which may exacerbate background effects.

Why did they add O3 in the toluene-HONO experiments? It seems to me it would be more comparable to experiments in other labs if it weren't present. I wonder if a toluene - H2O2 irradiation (no NOx or HONO) might have been better (or also useful) as a comparison with previous results. Experiments with no NOx remove the complications of SOA yields being dependent on NOx levels, and toluene has higher SOA yields when NOx is absent.

It is stated that there is no dilution in the chamber because of the flexible nature of the chamber and operation under positive pressure. However, they do not provide data to show that this is the case. Including an inert tracer in the chamber and monitoring its concentration during the experiments would provide the needed verification of no dilution. The chamber of Carter et al (2005) has a similar design in this regard (though not stated in this manuscript), and we occasionally observe dilution in this chamber despite the positive pressure. This is attributed to leaks, which is always a problem with Teflon film reactors, and which generally gets worse as reactors become more extensively used.

Because leaks can also introduce contamination as well as giving invalid calculations of amounts of compound reacted, tracers need to be included and leaks measured routinely with each experiment, not just when the chamber is first characterized. If dilution is observed, the source of the leaks need to be found and repaired, or the Teflon film walls need to be replaced.

Technical Corrections:

Figure 4 should be referenced when the blacklight light source is first mentioned in the section describing the construction of the chamber. As it is, it isn't referenced until the methods of the actinometry experiments are discussed.

It is unclear whether the "N/A"'s for the particle levels and yields in Table 2 for run T130909 is because the run formed no measurable PM or because the measurement was lacking. I assume it is the latter because Table 1 shows that this experiment seems quite close in conditions to the following experiment. In that case, they should add a note meaning that no data were taken, so the reader won't think that no PM was formed. If the N/A means that PM was monitored but below the measurement sensitivity, then it needs to be discussed why this run has such different results than the following run. A similar comment can be made about the "N/A"'s in Table 3.

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