

Several major concerns remain that were raised by the previous referees. I summarize them below, together with a detailed list of additional comments. Please clearly indicate in your response where and how you have addressed the comments in the revised manuscript.

### **I) Major comments**

1) I still share Referee #3's concern that the manuscript reads like a lab report rather than a scientific paper. The various experiments are listed but the connection between the experiments and their conclusions are not fully clear.

It would help if you referred to the various subsections within Section 3 to connect your results (e.g. can the kinetics be related to the reaction mechanism, how does the production of HULIS relate to the reaction mechanism etc?)

2) A lack of a coherent discussion was also expressed by Referee #1 who asked you to comment on the atmospheric relevance of the oxidant concentrations and their ratios.

Therefore, I suggest that you add a separate section on the discussion of the atmospheric relevance of your results. Please also include a brief discussion on the representativeness of eugenol, and how its reactivity can inform about SOA processing (formation and loss) by precursors of intermediate volatility.

3) You discuss the formation of HULIS and it seems at some places that you exchangeable use "HULIS" with aqSOA. Please define what HULIS are in your discussion and how 'humic-like' and atmospherically-relevant these products formed in the reactions are (cf. e.g. discussion by (Graber and Rudich, 2006)). Please check carefully your discussion of HULIS and how comparable the products in your experiments are to HULIS as referred to in the literature (e.g. line 672).

### **II. Minor comments**

1) l. 37/38: Keywords are not needed

2) l. 58: I share the referee #2's concerns that you do not properly cite previous literature on aqueous phase oxidation of organics, in particular of phenolic compounds. A huge number of kinetic and product studies for small VOCs and also for phenolic compounds have been performed before 2010 (the oldest currently cited paper here). Please cite also relevant older references of the aqueous phase oxidation of phenolic compounds. See for example review articles (Herrmann, 2003; Herrmann et al., 2015) and specific other studies (Barzaghi and Herrmann, 2002; Bonin et al., 2007; Sun et al., 2010)

3) l. 80/81: There are numerous studies that clearly state the role of ROS (including OH, H<sub>2</sub>O<sub>2</sub>) for SOA formation. Please include appropriate literature or revise this sentence.

4) l. 260: A 'rate' refers to a speed of a process; therefore, it has units of 1/time or concentration/time. Please clarify what  $\eta$  is. I assume you mean 'degree of degradation' (dimensionless)(?)

5) l. 319-338: This text needs to be clarified and further elaborated on (see also Referee#1's comment 1). It needs to be made clear whether these findings of the relative importance are only valid under your experimental conditions or also to the atmosphere.

6) Section 3.5.1: How do the aqSOA yields compare to those reported in other studies, e.g. (Ma et al., 2021; Smith et al., 2014)? Why do you find different values than in your previous study?

7) Section 3.6.2: How quantitative is this reaction mechanism? Were all intermediates and products identified by GC-MS or were some inferred?

### III. Technical comments

Please carefully proofread your manuscript and correct unclear language, grammar mistakes and typos. I added a long, but not exhaustive list below.

I. 18: 'under two radicals' should be 'in the presence of radicals'

I. 22: define 'ESP'

I. 45: replace 'are' by 'is' (aqSOA is singular)

I. 46: either 'less volatile' or 'have lower volatility'

I. 51: 'not yet' is redundant

I. 61/62: This sentence is not clear.

I. 63: I assume you do not mean  $^1\text{O}_2$  (singlet oxygen) and not molecular oxygen.

I. 66: 'predominant oxidant' is ambiguous. It is correct that the rate constants of OH reactions are usually much higher than those of the  $\text{NO}_3$  radical or other oxidants. However, other oxidants (such as  $\text{H}_2\text{O}_2$  or  $^1\text{O}_2$  (singlet oxygen) might be equally high or even higher)

I. 93/94: Why can vanillic acid be considered a proxy for HULIS?

I. 100/101: (1) Please add a reference to this sentence. (2) replace 'served' by 'serve'.

I. 107: replace 'has' by 'have'

I. 120/121: What do you mean by 'deeply clarifying the degradation mechanism'?

I. 142/3: 'At the bottom of sample tubes, there are fan and magnetic stir bar to make solution full mixed' – reword, e.g. 'To ensure mixing of the solution, a fan and a magnetic bar are placed at the bottom of the solution'.

I. 150/1: 'slightly lower' is not correct, if you refer to light intensity that is more than 60% lower than sun light.

I. 159: replace 'darkness' by 'dark'

I. 161: replace 'now' by 'not'

I.201: replace 'was' by 'were'

I. 222: 'for distinguish' – do you mean 'as a blank'? Please clarify.

I. 232: replace 'Products' by 'Product'

I. 245: 'CHO<sub>1</sub>' should be 'CHO'

I. 280: Unclear what 'they' refers to. Are you referring to chemical bonds in general or to a specific bond referred to in the previous sentence?

I. 285: Please reword this sentence, e.g., 'The pseudo-first-order rate constants were obtained by fitting eugenol concentration to the equation [please add equation number here!]. The experiments were performed under conditions of excess oxidants.'

I. 290/1: I do not understand this sentence: Are you saying that the oxidation by 3C\* is faster because it is a combination of multiple pathways including reactions with 1O<sub>2</sub>, O<sub>2</sub>- and OH? Please clarify.

I. 301: What does 'they' (were calculated) refer to? If you mean 'the relative importance', it should be 'it'.

I. 349: replace 'combing' by 'combining'

I. 371 – 373: This sentence is not clear. Please clarify.

I. 371: Do you really mean 'photolysis' here or 'photooxidation'?

I. 374: add 'by' (decreased by 56%).

Figure 3: The labels next to the lines in all panels are really hard to read. Please improve the figure quality.

I. 420: replace 'directly' with 'direct'

I. 424 – 426: This sentence is not clear. Please clarify.

I. 439: replace 'In a word' by 'In summary'

I. 497: fluorescent

I. 498: replace 'more intense' by 'higher intensity'

I. 504: replace 'photosensitise' by 'photosensitizer experiments'

I. 510 – 517: What is the main message of this text? Please reword and clarify.

I. 519: 'characterize aqSOA' is too general. Do you mean molecular composition or structure, optical properties, ...?

I. 500; I. 527: HULIS

I. 592 – 594: Please correct and clarify this sentence.

I. 644: This sentence seems redundant.

### References

Barzaghi, P. and Herrmann, H.: A mechanistic study of the oxidation of phenol by OH/NO<sub>2</sub>/NO<sub>3</sub> in aqueous solution, *Phys. Chem. Chem. Phys.*, 4, 3669–3675, 2002.

Bonin, J., Janik, I., Janik, D. and Bartels, D. M.: Reaction of the Hydroxyl Radical with Phenol in Water Up to Supercritical Conditions, *J. Phys. Chem. A*, 111(10), 1869–1878, doi:10.1021/jp0665325, 2007.

Graber, E. R. and Rudich, Y.: Atmospheric HULIS: how humic-like are they? A comprehensive and critical review, *Atmos. Chem. Phys.*, 6, 729–753 [online] Available from: <http://www.atmos-chem-phys.net/6/729/2006/acp-6-729-2006.pdf>, 2006.

Herrmann, H.: Kinetics of aqueous phase reactions relevant for atmospheric chemistry, *Chem. Rev.*, 103(12), 4691–4716, 2003.

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