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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Morphology and size of the particles emitted from a GDI-engine vehicle and their ageing in an environmental chamber" *by* Jiaoping Xing et al.

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Point-to-point responses to the comments:

Anonymous Referee #1 It is a well designed and prepared work related with the emission of single particle emission from gasoline vehicle emission and aging activities, with methods including TEMEDX, chassis dynamometer, smoke chamber in ambient air condition, etc. adopted. It should be emphasized that this kind of works are still limited, especially in China, as the limitation of equipments, sampling platform, and so on. I really admire the study design. The data also provide evidence of the impact of gasoline vehicle emission on ambient air of megacities like Beijing. I suggested it can

be accepted for ACP. Some concerns are listed below. Response: The authors show their appreciation to the reviewer for the comments and suggestions. Here I describe the point-to-point responses to the comments and questions.

1. Line 80-83, coal combustion is still a problem in northern China. The authors should clarify this sentence. Response: We fully agree with this comment. In order to avoid the misunderstanding, we added "In spite of this, regional transport of coal-burning emissions from the surrounding areas can still influence the urban air sometimes severely in winter (Ma et al., 2017; Zhang et al., 2019)" in the end of the mentioned paragraph.

References: Ma, Q., Wu, Y., Zhang, D., Wang, X., Xia, Y., Liu, X., Tian, P., Han, Z., Xia, X., Wang, Y., and Zhang, R.: Roles of regional transport and heterogeneous reactions in the PM2.5 increase during winter haze episodes in Beijing, Sci Total Environ, 599, 246-253, 10.1016/j.scitotenv.2017.04.193, 2017. Zhang, M., Li, Z., Xu, M., Yue, J., Cai, Z., Yung, K.K.L., and Li, R.: Pollution characteristics, source apportionment and health risks assessment of fine particulate matter during a typical winter and summer time period in urban Taiyuan, China, Hum Ecol Risk Assess, 10.1080/10807039.2019.1684184, 2019.

2. I am not sure why H2O2 was added in the chamber and why such amounts were added. What is the concentrations for the formation of OH through H2O2 photolysis. More detailed information should be listed. Response: H2O2 was injected into the chamber as the source of hydroxyl radical (OH). Please refer to descriptions in line 206-212. In the revision, to make this more clear, we have added in line 206-212 "Assuming the 24 hr mean concentration of 106 OH molecules cm-3 in Beijing (Lu et al., 2013), the OH exposure at the end of the experiments reproduced extreme oxidation processes in the atmosphere, which is equivalent to cases of an oxidation more than 10 days. The aging experiments for the gasoline exhausts were carried out with a relatively high OH exposure compared to ambient conditions in order to obtain the aging process. This method and the amount of H2O2 have been frequently used in smog chamber experiments (Song et al., 2007; Song et al., 2019)."

References: Lu, K.D., Hofzumahaus, A., Holland, F., Bohn, B., Brauers, T., Fuchs, H., Hu, M., Häseler, R., Kita, K., Kondo, Y., Li, X., Lou, S.R., Oebel, A., Shao, M., Zeng, L.M., Wahner, A., Zhu, T., Zhang, Y.H., and Rohrer, F.: Missing OH source in a suburban environment near Beijing: observed and modelled OH and HO2 concentrations in summer 2006, Atmos Chem Phys, 13, 1057-1080, 10.5194/acp-13-1057-2013, 2013. Song, C., Na, K., Warren, B., Malloy, Q., and Cocker, D.R.: Secondary Organic Aerosol Formation from m-Xylene in the Absence of NOx, Environ Sci Technol, 41, 7409-7416, 10.1021/es070429r, 2007. Song, M., Zhang, C., Wu, H., Mu, Y., Ma, Z., Zhang, Y., Liu, J., and Li, X.: The influence of OH concentration on SOA formation from isoprene photooxidation, Sci Total Environ, 650, 951-957, 10.1016/j.scitotenv.2018.09.084, 2019.

3. Can you get the real solar radiation data from local weather bureau. Response: We are not able to obtain the in-situ solar radiation data from local meteorology bureau. For this reason, we use the simulated data.

4. Why acid-catalyzed mechanism important for SOA formation in vehicle emission aging? Do you have other data or deep analysis? Response: According to published literature (Kuwata et al., 2015; Jang et al., 2002; Jang et al., 2004; Beardsley and Jang, 2015), we believe that the acid-catalyzed mechanisms are major path for SOA formation, and at least our results are consistent with the results.

In the revision, the following descriptions are added in line 416-429. “The mixture of SOA and sulfate have been detected in our chamber experiment, indicating the involvement of inorganic salts in the SOA formation. Previous studies have demonstrated the enhancement of SOA production in the presence of inorganic sulfate (Beardsley and Jang, 2015; Kuwata et al., 2015), and this is because sulfate can catalyze carbonyl heterogeneous reactions, and consequently, lead to SOA production (Jang et al., 2002; Jang et al., 2004). Sulfate and secondary organic aerosol (SOA) co-existed on the surface of primary particles, such as soot, Ca-rich and organic particles. In addition, the products of VOCs oxidation could react with SO2 to rapidly produce sulfate (Mauldin et al., 2012).” All these results have demonstrated the potential importance of

acid-catalyzed mechanisms for SOA formation in aging of vehicle emission. The references: Beardsley, R.L., and Jang, M.: Simulating the SOA formation of isoprene from partitioning and aerosol phase reactions in the presence of inorganics, Atmospheric Chemistry and Physics Discussions, 15, 33121-33159, 10.5194/acpd-15-33121-2015, 2015. Kuwata, M., Liu, Y., McKinney, K., and Martin, S.T.: Physical state and acidity of inorganic sulfate can regulate the production of secondary organic material from isoprene photooxidation products, Physical chemistry chemical physics: PCCP, 17, 5670-5678, 10.1039/C4CP04942J, 2015.

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