



Oxidative Potential and Chemical Characteristics of Ambient PM_{2.5} in Guangzhou, China

Peng Cheng¹, Manman Zhang^{1,2}, Yongjie Li³, Mingjin Tang⁴, Wenda Yang¹, Cheng Wu¹ and Jiayin Sun¹

1. Jinan University, Institute of Mass Spectrometer and Atmospheric Environment, China, 2. Henan University of Chinese Medicine, Department of Pharmacy, China, 3. University of Macau, Department of Civil and Environmental Engineering, China, 4. Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, State Key Laboratory of Organic Geochemistry, China

Introduction

Oxidation potential that determines the capability of reactive oxygen species (ROS) generation is widely used to characterize the impact of PM_{2.5} on human health. In January and April 2018, we measured the dithiothreitol (DTT) assay of daily PM_{2.5} samples collected in Guangzhou, China with complimentary measurements of water-soluble ions, organic/elemental carbon (OC/EC) and metal elements. Correlations between DTT and chemical compositions of PM_{2.5} were analyzed. Contribution of soluble metals to DTT assay was also evaluated by addition of EDTA.

Materials & Methods

The DTT assay is used to characterize the Oxidative Potential (OP) of atmospheric particulate matter (PM). Agitation, instead of ultrasonication was adopted as the extraction method to avoid ROS generation during sample preparation. EC/OC were measured on-line. Water-soluble ions and heavy metals were analyzed by IC and ICP-MS, respectively.

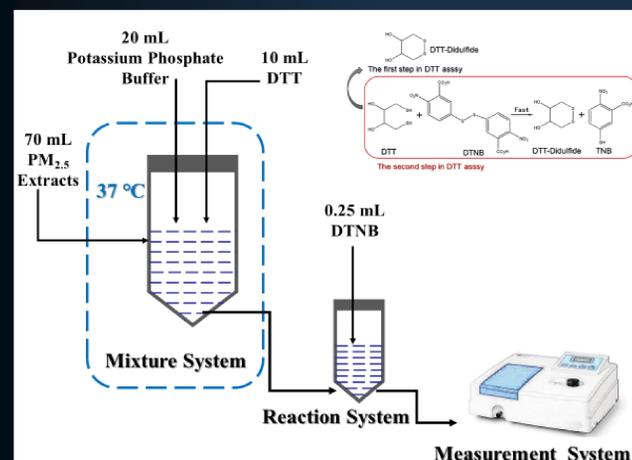


Figure 1 The experimental flow chart of the DTT assay

Results and Discussion

The average sampled air volume normalized consumption rate of DTT (DTTv) was 4.67 ± 1.06 and 4.45 ± 1.02 nmol min⁻¹ m⁻³, in January and April, respectively while the average PM_{2.5} mass normalized consumption rate of DTT (DTTm) was 13.47 ± 3.86 and 14.66 ± 4.49 pmol min⁻¹ μg⁻¹.

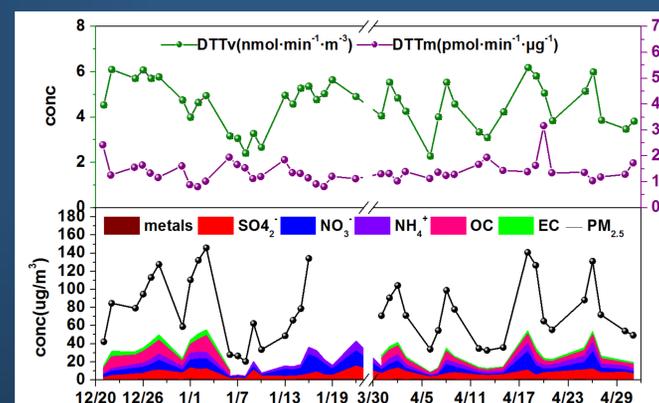


Figure 2 Temporal variations of PM_{2.5} mass concentration, chemical compositions and OP values (DTTm and DTTv).

Figure 3 shows the OP values measured with and without EDTA addition. The OP of PM_{2.5} in January and April (DTTv, nmol min⁻¹ m⁻³) decreased by 84.4% and 90.0%, respectively, after the addition of EDTA.

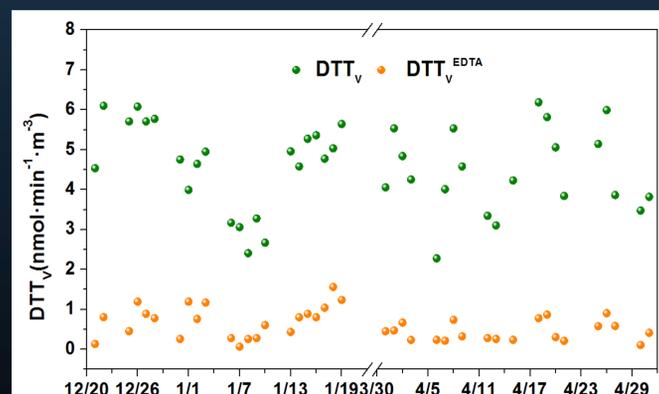


Figure 3 The change of DTTv before and after adding EDTA-Na₂

The contributions of major heavy metals to OP values was estimated based on parameterization from literature (Charrier et al., 2012). The reconstructed OP was 137% in January and 112% in April, on average 125%, which suggested that the parameterization can be applicable in our study with some uncertainties. Overall, more than 90% of OP of PM_{2.5} were from Cu (II) and Mn (II), while other elements such as Fe, V, Co, Ni, and Pb contributed less than 1% of OP in PM_{2.5} in Guangzhou.

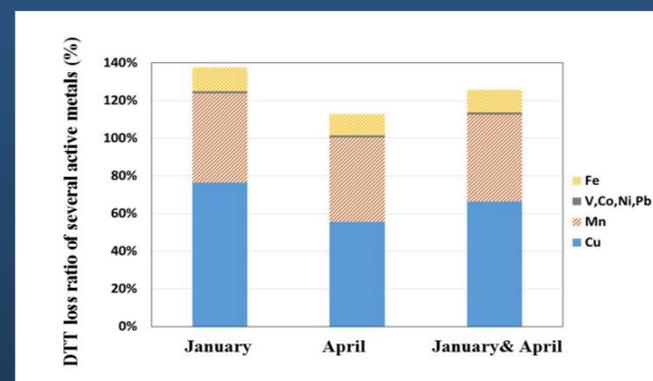


Figure 4 Calculated average contributions to DTT loss by seven metals in atmospheric PM_{2.5}

The correlation coefficient between DTTm and OC shows a clear increase after addition of EDTA, implying that the response of DTT to quinones is not strongly suppressed by EDTA

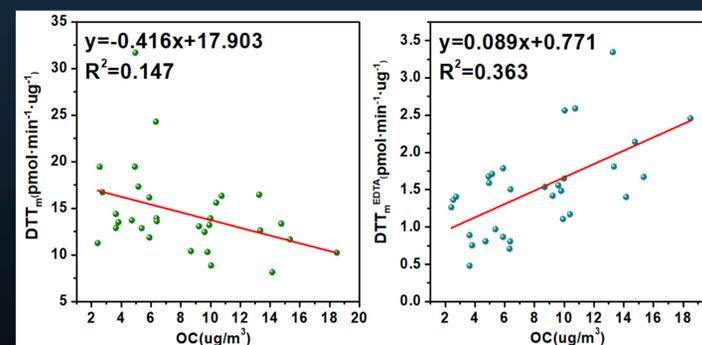


Figure 5 The change of DTTv before and after adding EDTA-Na₂

Conclusions

- The average value of DTTv was 4.67 ± 1.06 and 4.45 ± 1.02 nmol min⁻¹ m⁻³ in January and April respectively; and DTTm was 13.47 ± 3.86 and 14.66 ± 4.49 pmol min⁻¹ μg⁻¹.
- Good correlations were found between DTTv and concentration of PM_{2.5}, OC, and EC while no correlation was found between DTTm and concentrations of water-soluble ions, OC, EC or metal element, which is consistent with most early observations.
- Soluble metals dominate the response of DTT to ambient PM_{2.5}, and Cu(II) and Mn(II) may be the major contributors to OP of PM_{2.5} in Guangzhou.
- Response of DTT to quinones is much smaller than metals, and not strongly suppressed by EDTA

Acknowledgement

This research was supported by National Natural Science Foundation of China (No. 91644218) and State Key Laboratory of Organic Geochemistry, GIGCAS (Grant No. SKLOG-201719)

References

Charrier J G, Anastasio C. On dithiothreitol (DTT) as a measure of oxidative potential for ambient particles: evidence for the importance of soluble transition metals [J]. Atmospheric Chemistry & Physics, 2012, 12(5):11317

Contact

ChengP@jnu.edu.cn

