

Response to comments #1:

Thanks very much for your comments, suggestions and recommendation with respect to publish this paper in AMT. Our response to all your comments are as follows.

The manuscript describes a method of portable multi-channel gas analyzer with an optimized

retrieval algorithm to monitor accurately the industrial SO₂ emissions with large measurement range and correction for interferences of other infrared absorbers. The good performance was shown in a large dynamic measure range and further in field measurements of different factories' emissions. Overall, it is a new improved and applicable measurement technique with future prospects in practice. And the manuscript meets the scope of the journal and I would recommend publication. Some comments and suggestions are following.

1. Instrument: why the sample cell was controlled at 343 K? Any impacts of the sample cell temperature on the measurement? It's better if the authors could show some sensitivity test about this considering the industrial emission was varied in a wide range of temperature.

Response: We use a temperature controller to keep the sample cell at 343 K(50 °C) and a capillary to keep the sample being pumped at a constant rate of ~1L/min. They are some explanations to your comments. In detail:

1. The drifts of temperature and pressure will alter the calibration coefficients via altering the gases absorption intensities (the temperature and pressure dependency of the cross section were described in various references as Sparks, 1997; Martin et al., 1998; Rothman et al., 2005 and 2009, et al.), resulting in measurements drift. The temperature controller and the capillary can keep the sample at constant temperature and pressure, respectively. Thus, measurement biases as this kind can be avoided.

2. High temperature will injure the optical components in the sample cell (e.g., optical filters or mirrors). Low temperature will liquefy the water vapor and then damage the optical components. Furthermore, low temperature is easier influenced by the ambient circumstance than high temperature, i.e., it's not easy to stabilize a low temperature. When taking every thing into account, the optimal temperature should be higher than the circumstance even in extreme cases, but lower than a threshold. Actually, backed by our experience, a temperature ranging from 45°C to 70°C is acceptable. 343K (50 °C) is within this region.

3. The temperature of the sample cell is not equal to the temperature of the industrial emissions. The temperature of the sample cell is kept at 343K but the industrial emission varied in a wide range of temperature, e.g., from several °C to hundreds of °C. We use a transition system, i.e., the pretreatment system to connect the instrument and the industrial stack. The measurement procedures are as follows: The sample gases (regardless of the temperature) are pumped into the pretreatment system via a heat-tracing pipe. The pretreatment system will remove dusts and most water vapor. After finishing the removal task, the pretreatment system will cool down the sample and direct them into instrument for analysis. The heat-tracing pipe is kept at 180°C

but the sample after the pretreatment system is kept at 343K (50 °C). Before the pretreatment system, the sample gases have lots of water vapor which will be liquidized if huge temperature change exists. The SO₂ or other interfering gases will dissolve into liquid water, resulting in 'false' measurement, i.e., the measurement is not equal to the true concentration in the stack. That's why we kept the heat-tracing pipe at a temperature of 180°C. After the pretreatment system, most water vapor are removed. Decreasing the temperature from 180°C to 50 °C did not influence the measurements. We only given a brief introduction about this system in this study and further details can be found in Sun et al. (2013) AMT. I already cited this reference in corresponding contents.

4. The multi-channel analyzer has been deployed to monitor SO₂ emissions of three factories. These three factories not only provide different interfering gas types and concentration levels, but also exhibit different temperature variations. It can be concluded from measurement comparisons that the multi-channel analyzer is capable of monitoring SO₂ emissions in various industrial applications regardless of temperature. Furthermore, the temperature variations of the industrial emissions don't affects the temperature of the samples in the sample cell (see above 3 for details). So I think the sensitivity study to the industrial temperature is not absolutely needed.

2. In abstract, which kind of the effects “have been the major limitations of industrial SO₂ emissions monitoring”? Please rephrase this sentence more clearly.

Response: This will be rephrased to the following sentences in the AMT version.

Thanks a lot.

"Varying in a huge concentration region and easily being interfered by other gases have been the major limitations of industrial SO₂ emissions monitoring. In this paper, we demonstrate achieving accurate industrial SO₂ emissions monitoring using a portable multi-channel gas analyzer with an optimized retrieval algorithm. The introduced analyzer features with large dynamic measurement range and correction of interferences from other co-existing infrared absorbers, e.g., NO, CO, CO₂, NO₂, CH₄, HC, N₂O and H₂O. The multi-channel gas analyzer measures 11 different wavelength channels simultaneously in order to achieve correction of several major problems of an infrared gas analyzer.....".

3. Could the author give more details of about the comparison with DOAS analyzer in field campaign? e.g. the DOAS analyzer setup? any difference of sampling between this two method? Some explanations of the absolute difference between two instruments?

Response: Here I would like to answer your comments point by point, in detail:

a) e.g. the DOAS analyzer setup?

Response: In the AMT version, I would like to briefly introduce the specification of the DOAS analyzer, then cite a reference (a web link) that introduce this DOAS analyzer in detail.

b) any difference of sampling between this two method?

Response: The sampling system of both analyzers are the same, please check Fig.12

in the AMTD version and the corresponding context for details.

c) Some explanations of the absolute difference between two instruments?

Response: Two aspects can probably result in absolute difference.

No.1: The volume of the sample cell in the multi-channel analyzer is larger than that in the DOAS analyzer. The reading of each analyzer are the averaged concentration of the sample in the cell. If the measurement conditions changed or in other words, the condition in the stack changed abruptly. The discrepancy would arise.

No. 2: Another reason is the drifts of zero and span calibration factors. We perform all measurements within 10 days which do not beyond the calibration period. So difference as this kind is of secondary importance.

I will add above analysis in the AMT version.

4. P13333, line 23, what is the study of Sun et al., 2013 referred to? It is absent in the reference. Please re-check all the references referred in the body part and corresponded one in the References.

Response: Sorry for the mistake, we will include this reference in the AMT version.

We will also re-check all the references referred in the body part and corresponded one in the references.

5. The resolution of Fig. 4 is poor to read.

Response: The original figure is drawn with a software Visio and is very clear. It looks pretty poor in the AMTD probably caused by typesetting. We will upload the new figure in the AMT version.