

# ***Interactive comment on “An instrument for the rapid quantification of PM oxidative potential: the Particle Into Nitroxide Quencher (PINQ)” by R. A. Brown et al.***

**R. A. Brown et al.**

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Received and published: 30 December 2018

Comment 1

The instrument is not sufficiently described, e.g. size data of the “Insoluble Aerosol Collector” (IAC) should be added to estimate the flow regime.

Response 1

The authors agree, and have provided information on the internal IAC dimensions in Sect 2.2. in the updated manuscript.

Comment 2

The authors stated that the instrument is measuring ROS of particle matter (PM) – is that correct? ROS in gas phase (not associated completely with PM, e.g. H<sub>2</sub>O<sub>2</sub>) should be collected too, if the gas/particle distribution is shifted towards particles (droplets) after adding condensing water vapor. The relevance of this process should be discussed. If important, loss of gaseous ROS must be determined or measures as e.g. installing a charcoal denuder prior to PM collection should be considered. Perhaps the term “particle” should be replaced by “aerosol”, defined as mixture of gas, particles and droplets.

### Response 2

The collection of gas phase species was noted in Sect 5. However it has been moved and expanded upon in a dedicated Sect 4.3. in the updated manuscript. During measurement the instrument should alternate between filtered and unfiltered samples in order to account for the gas phase contribution. Another approach would be using a denuder as described by the reviewer. However, the concern with this method would be the losses of ultrafine particles in the denuder prior to sampling (Stevanovic et al., 2015). Currently the IAC is only characterized for PM collection, with the gas phase collection of interest but still in the very early stages of investigation due to its inherent difficulty. The authors feel it would be premature to claim aerosol collection until the gas phase is fully characterized. Instead, in any sampling campaign the inlet will be periodically switched to sample after a filter to account for gas phase measurements to present a purely particle phase result. Gas phase data can be interpreted to some degree, however until characterization it is semi-quantitative at best. Accounting for the gas phase contribution was not performed in the response time experiments as the total aerosol response was of interest.

### Comment 3

In section 1 several probes and collection devices reviewed. It will be helpful, if the probe dependent targeted ROS species (O-centered-, C-centered-radicals, . . .) will

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be discussed more detailed to enable interpretation of the different end-points.

### Response 3

Some information on the sensitivity of the different major probes discussed has been added in the updated manuscript in Sect 1.2.

### Comment 4

Page1 line 18: Replace “. . .(Nel, 2005)(Penttinen et al.,2001); and . . .” by “. . .(Nel, 2005; Penttinen et al.,2001) and . . .”

Response 4 This has been corrected in the updated manuscript in Page 1, Line 18-19.

### Comment 5

Page 2, line 26: “. . .are only sensitive to narrow ranges of ROS species; making them unsuited for quantification of total oxidative potential.” Here a more detailed discussion on determined ROS species will be helpful

### Response 5

The discussion regarding difference ROS species and the use of phrase oxidative potential has been added in Sect 1.2.

### Comment 6

Section 1.3: Subtitle should be replaced by “online collection techniques”, as chemical assays are discussed in section 1.2.

### Response 6

This has been corrected in the updated manuscript at Page 3, Line 29.

### Comment 7

Page 5 line 19 and page 6 line 9 and 10 and some other occurrences: “. . .”sample resolution” means “. . .time resolution. . .”

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## Response 7

All incidents of sample resolution have been replaced with time resolution in the updated manuscript.

## Comment 8

Page 7 line 7-8: Where is the aerosol flow rate measured?

## Response 8

The aerosol flowrate is set prior to, and checked after measurement using a TSI 4043 mass flow meter placed in line between the sampling line and the PINQ inlet. This was found to be stable over long periods (24 hours with no significant variance) and more reliable than a mass flow controller which suffered from issues with condensation. This has been updated in the current manuscript at Page 7, Line 16-17.

## Comment 9

Page 8 line 9: A mass flow in  $\text{g}\cdot\text{min}^{-1}$  will be more exact, additionally the dew point temperature of the supersaturated aerosol flow will be a vivid parameter.

## Response 9

A mass flow of  $\text{g}\cdot\text{min}^{-1}$  would be more exact, however the peristaltic pump is a volumetric device and hence a volume flow is provided.  $1.5\text{mL}\cdot\text{min}^{-1}$  provides an excess of supersaturation which will still be achieved with small variances caused by density changes caused by changes in different laboratory environments. If the instrument is operated in extreme environments with significantly elevated or lowered temperatures tests would have to be performed to ensure viability. This clarification has been included in the updated manuscript. In regards to dew point temperature, the goal of the system is to provide excessive supersaturation to grow even the smallest hydrophobic particles into liquid droplets. As such the resultant aerosol will be well below the dew point temperature in all circumstances, and hence it is not a parameter of interest here.

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## Comment 10

Page 8 line 13: Why is the excess condensation drain volume not measured for calculation of the steam dilution factor? Can the excess drain water be analysed further for cross checking particle losses and removal of gaseous components?

## Response 10

The steam dilution factor cannot be calculated using the chamber drain line, as you would also need to account for the water collected in the liquid trap and any condensation in tubing connected to the exhaust line of the instrument. The IC analysis during the ammonium sulphate collection experiments provided a significantly more accurate and direct way of measuring this value at Page 8 Line 1-4. As shown in the manuscript, the PM mass collected by the IAC is within error of the aerosol sample mass. Whilst there is inevitably some particle losses in the chamber, these losses constitute a very small mass portion of the aerosol. Beyond issues regarding how effectively the chamber is washed by the condensation to remove particle deposition, the concentrations of ammonium sulphate in the mass concentration in the chamber drain would be below the limit of detection of the IC system. The removal of gaseous components could be potentially significant and is of potential interest in the future. However, the gas phase collection is not considered in this publication.

## Comment 11

Section 3.1.2: Did the authors check, if the charcoal denuder really removes all ethanol vapour from DEHS particles? If there is only a small amount of ethanol left on the surface of the particles, they still have a hydrophilic character.

## Response 11

The charcoal denuder will remove a substantial portion of the ethanol from the aerosol source. The aerosol is then effectively diluted at a ratio of 10 to 1 inside the SMPS due to the sheath air interaction, and diluted again at a ratio of 15.7 to 1 when mixed with the

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makeup aerosol to generate the required flowrate. Given the volatility of ethanol is so high and the combination of two dilution stages the authors are confident that ethanol will only be present in trace concentrations and will not influence the hydrophobicity of the particles.

Comment 12

Page 11 line 29-30: Particle mass increases with 3rd order to particle diameter/size, not exponentially

Response 12

This has been corrected in the updated manuscript at Page 12, Line 16.

Comment 13

Page 12 line 10 and page 16 line 3: "Sect. 0" is not defined

Response 13

This has been corrected in the updated manuscript.

Please also note the supplement to this comment:

<https://www.atmos-meas-tech-discuss.net/amt-2018-333/amt-2018-333-AC1-supplement.pdf>

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-333, 2018.

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