

## **Review of the AMT manuscript amt-2019-78**

“MEMS-based condensation particle counter for real-time monitoring of airborne ultrafine particles at a point of interest”

by S.-J. Yoo et al., 2019

The above manuscript deals with description and characterization of a miniaturized Condensation Particle Counter (CPC). As CPCs are widely used in aerosol science and small and light CPCs were lacking in the past, the new approach is highly welcome and important. The manuscript is well structured and I have only comments which should be addressed by the authors to improve the manuscript.

### **General remarks:**

The manuscript is well structured, however the last two paragraphs of the introduction read like a summary. They forestall important results from the following sections. The introduction is not the right place for this information. Please change and shorten these last two paragraphs. My suggestion, instead of presenting results, you should write something like:

“Traditional CPC geometries do not allow for a much smaller size and weight ... they are not suited for batch production ... we tried a new technique ... based on ...”

This would fit perfect to the end of the introduction.

But this is just an suggestion.

### **Specific remarks:**

Title:

- Please write-out “MEMS”, as this abbreviation is relatively unknown to the atmospheric community.

- Please remove “at a point of interest” because this statement I not very specific and a user of this new instrument will always only measure “at a point of interest”. Moreover, I’m not a native speaker, but it seems for me that this wording might be understood as “sight-seeing point” as well.

Same for the abstract, remove “at a point of interest” as well; there it also causes a reference error, the “point of interest” is not “portable, ...”.

Abstract:

- p. 1, l. 15: Please specify if the given size information (nm) are for particle “diameter” or “radius”. Please do so in the whole manuscript.

- p. 1, l. 16: Please specify which “deviation” is meant, standard deviation?

## Introduction:

- p. 1, l. 22: “Monitoring of airborne ultrafine particles ...yield(s !) enhancement in industry fields”

I can imagine what the authors meant with this sentence, but actually I do not understand it. Please rephrase.

- p. 1, l. 22: Some reference in the introduction seem for me to be very old, many 199Xs. There might be some very fundamental among those, but the last 20 years definitely brought some progress. Please check if there are newer references.

- p. 1, l. 23: “UFPs are mainly generated from burning fossil fuels ...”. This statement is not generally true, the main particle formation process is gas to particle formation and fossil fuel burning might be dominant in cities only.

- p. 2, l. 6: Please insert “e.g.” before mentioning the TSI 3007”. There are other models as well, e.g. from KANOMAX.

## CPC Description

- p. 2, l. 35: I might have missed it, but you don't specify in the whole manuscript which working fluid was used. Did you try different ones? This information is essential for this technical paper and should be provided to the reader.

- p. 2, l. 40: In the supplement is only one figure. It seems strange to me to have a supplement because of just one figure. I suggest to incorporate it into the main manuscript.

If I remember correctly, in the traditional CPCs the particles grow more or less to the same droplet size, but in this new type there is a strong increase in droplet size with initial particle diameter (Fig. S1). How far does this go? Are even 20 or 30  $\mu\text{m}$  droplets generated? How does this affect the counting efficiency of your new CPC for larger particles (sedimentation)? Please comment in the manuscript on that, if this is an issue.

- p. 3, l. 19: I did not fully understand what the micropillars in the condenser do. They are needed to prevent droplet formation, which could clog the channel, fine, but how exactly do they do this? Please explain more in detail.

- p. 3, l. 22: Why is the pitch between the micropillars in the condenser not provided as number? All other dimensions are provided.

- p. 3, l. 29: If the Reynolds number in the system is so low (below 32) don't you get problems with secondary flows, i.e. convection? Could you check this for instance using the Richardson number? How are the diffusional losses for such a flow? Please provide some numbers.

## Experimental setup

- p. 4, l. 20: How long were the sampling lines? Which flow splitter was used? How is the flow geometry there? Did you have the same volume flow to all instruments (probably not, see Fig. 4)? A flow splitter can introduce strong deviations in the particle number concentration for different instruments connected to the flow splitter, in particular when using different

volume flows, because the particles are not necessarily distributed homogeneously over the sampling line. Please add the information on how the flow split exactly looks like and how you guaranteed that all three instruments good the same particle number concentration. According to Fig 4c I would guess for very small particles this was not the case.

## Results and discussion

- p. 4, l. 37: The “dry out-region” (maybe better “dry out region?”), how were they identified? The red areas in Fig. 5 “show” them, but I see no difference in the photo inside the read areas and outside.
- p. 5, l. 7: The activation efficiency is described as “the condensation chip at growing droplets” which I do not understand or feel to say something wrong. The activation efficiency is the fraction of particles being activated to droplets in the condensation chip.
- p. 5, l. 9: Please add “in particular for small particles below ca. 30 nm” after “... on particle size,” because the mentioned dependencies are mainly valid for this range.
- p. 5, l. 16: Fig. 6, how often was the counting efficiency curve measured? The day to day slightly different set-up can influence the curve, hence it should be measured at least three times, ideally on different days. How were the temperature settings and how does the counting efficiency change with different temperature settings?
- p. 5, l. 20: “diffusivity of particles is inversely proportional to the size”, is this true? How about the slip correction which brings a non-linear term into the particle diffusion problem?
- p. 5, l. 24: Again, how large do the droplet in your CPC get at maximum and is sedimentation really no problem?

## Figures

- Fig. 1: I believe the miniature OPC scheme is incomplete. I cannot imagine that this OPC works in the forward scattering mode without using a beam blocker. Is this really true?
- Fig. 5: Please add the unit “s” to the times provided above the photos.
- Fig. 6.: Please provide uncertainty bars to the plot.

## Technical corrections:

- p. 1 l. 12: Please remove “the” before “3D”.
- p. 1, l. 17: Please replace “range of” with “range is”, otherwise a verb would be missing.
- p. 1, l. 17: The correct CF unit for the particle number concentration should be “1/cm<sup>3</sup>”, without “N”. Please correct in the whole manuscript.
- p. 1, l. 22: A space is missing in before the “(“.... This occurs several times in the manuscript, please correct.
- p. 2, l. 7: Please remove “for ownership”, this addition is not needed here.

- p. 2, l. 18: Please remove the comma after “chip”
- p. 2, l. 33: Please insert “to” before “grow”.
- p. 3, l. 2: Please exchange “proposed” with a different word, e.g. “new”. The MEMS CPC is existing, you do not “propose” it.
- p. 3, l. 7: Please insert “micropillar” before “dimensions”.
- p. 3, l. 18: Please insert “to” before “control”.
- p. 3, l. 19: “... some” what? “may condense on the wall”, please specify that you mean the working fluid vapor.
- p. 4, l. 14: Please exchange “They” with “The particles”.
- p. 5, l. 4: Please delete “drawn”
- p. 5, l. 38: “the lower concentration limit of the aerosol electrometer was relatively high”  
Please rephrase, there is no “lower concentration limit” for an electrometer, however, because of the electronic noise you cannot trust the measured concentrations below a few hundred particles per cubic centimeter.
- p. 7: The format of some references are different compared to the others, e.g., Hajjam et al, 2010 or Kim et al., 2015. There are more, please check all.