

## Repeatability study of detection efficiency during CPC calibration using poly-alpha-olefin aerosol.

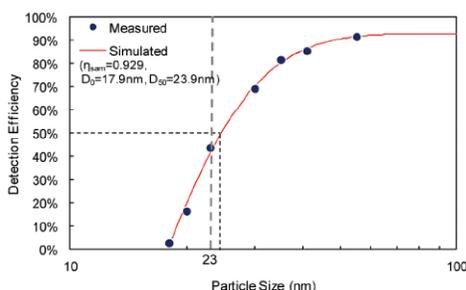
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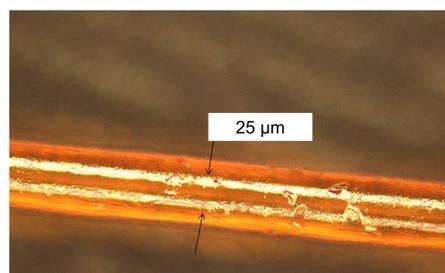
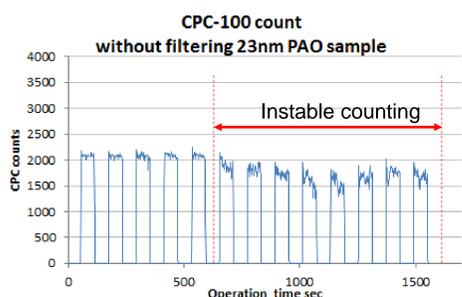
### 1. Objective

An International Standard for the calibration of condensation particle counters (CPC) has been published in March 2015. This ISO27891 describes methods to determine the detection efficiency of CPCs together with the associated measurement uncertainty.



- In this study the detection efficiency measurement procedure is based on ISO27891 utilizing an electrometer as the reference instrument.
- The detection efficiency curve of a CPC-100 can be seen on the left.
- PAO aerosol was used to satisfy the requirements from Regulation 83.

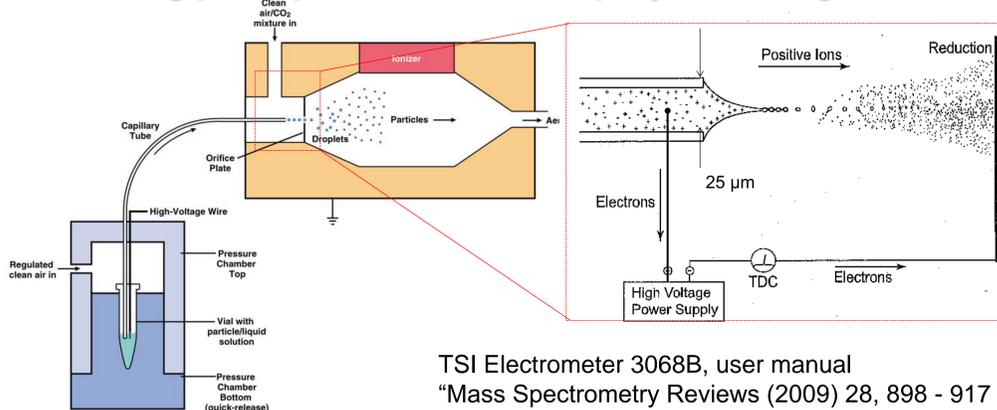
### 2. Instable CPC counting (with unfiltered PAO solution)



Optical image of micro capillary, which is taken in instable counting

- A sudden instability in the CPC counting was observed during calibration.
- One potential cause of error might be related to a contamination in the micro capillary of the electro spray leading to an instable counting.

### 3. Working principle of the electro spray aerosol generator



- Physical parameters should be considered for a stable PAO aerosol supply:
  - High viscosity** (Handling might be improved by using a high pressure spray unit).
  - Very low conductivity** (Conductive additives might be added taking into account their solubility and stability in the PAO solution).
- The solution treatment shows possibility for improvements in terms of a stable aerosol supply.

### 4. Preparation procedure of filtered pre-mixed PAO solution

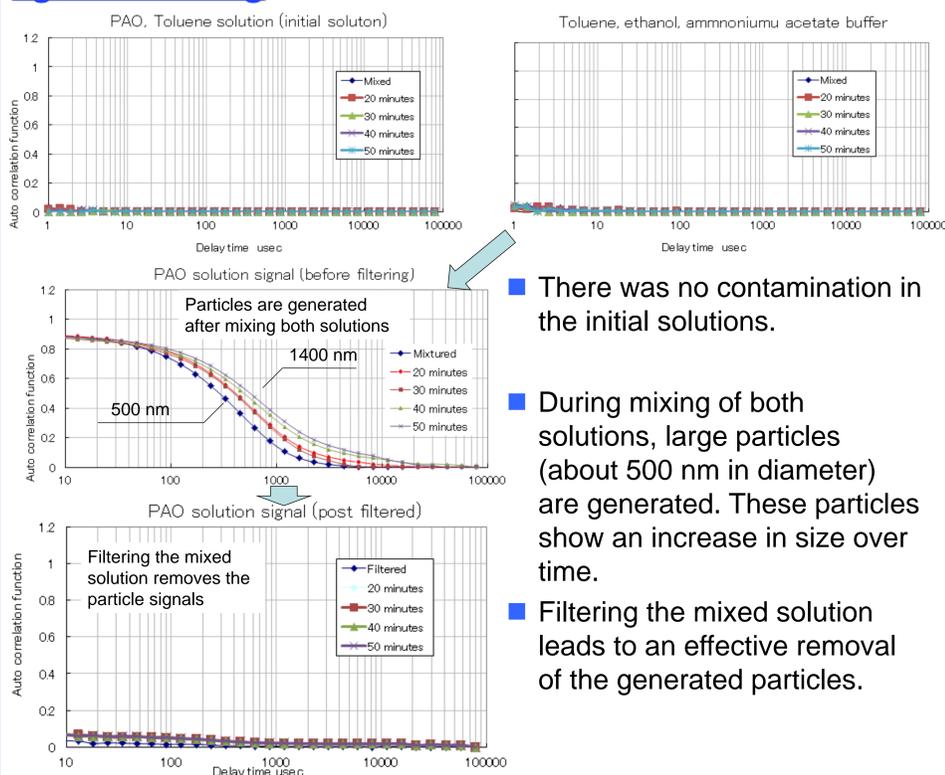
Poly-alpha-olefin•Toluene (raw PAO solution, cleaned by filtering) + Toluene•Ethanol•Ammonium acetate (buffer solution, cleaned by filtering)



- Filtered and unfiltered PAO solution are compared in terms of the solubility state and the counting stability using a CPC-100.

Used filter : Millex syringe filter 200 nm (PTFE)

### 5. Solution state analysis of PAO particles by dynamic light scattering

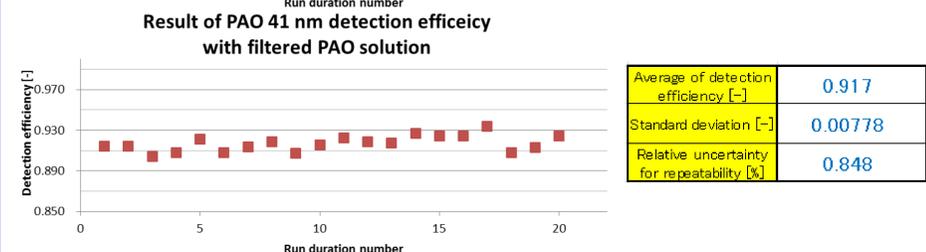
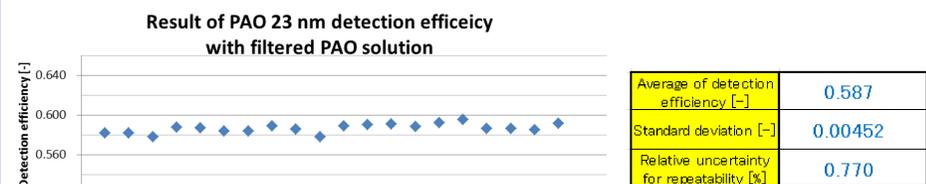
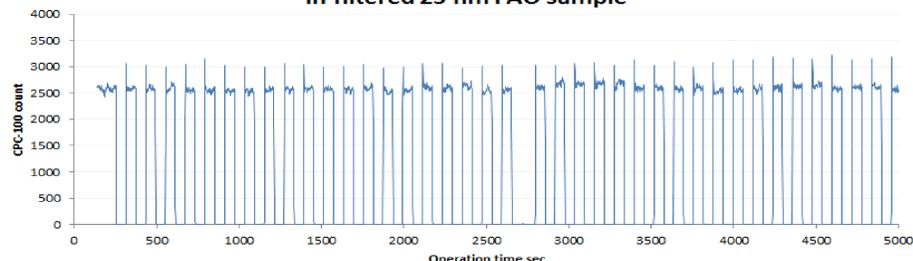


- There was no contamination in the initial solutions.
- During mixing of both solutions, large particles (about 500 nm in diameter) are generated. These particles show an increase in size over time.
- Filtering the mixed solution leads to an effective removal of the generated particles.

### 6. Repeatability study of CPC detection efficiency using filtered pre-mixed PAO solution

- Filtering the pre-mixed PAO solution leads to an improved stability in the aerosol generation. By that long measurement periods can be realized.
- The repeatability of the CPC detection efficiency and the associated measurement uncertainty is improved significantly.

CPC-100 counting result for long time operation time in filtered 23 nm PAO sample



### 7. Conclusion

- Solid particles were found in the micro capillary of the electro spray aerosol generator leading to an unstable counting during CPC calibration.
- An improved repeatability for the CPC detection efficiency measurement could be achieved by filtering the mixed solution. This stabilizes the PAO aerosol generation over a long period of time.

### 8. Acknowledgement

The authors would like to thank Dr. Hiromu Sakurai and Ms. Yoshiko Murashima (AIST) for instructive discussions during the course of this work.