Characterising the PMP "Golden Instrument" Verification of the Volatile Particle Remover

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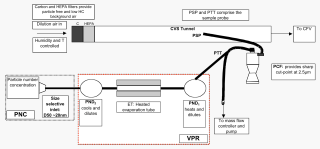
background

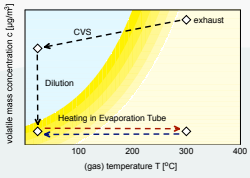
- PMP plans to introduce new particle emission limit
- measure the number concentration of non-volatile, solid particles
- instrumentation includes
  - sampling from CVS
  - pre-classifier with 2.5 µm cutoff
  - diluter 1:100
  - evaporation tube
  - secondary diluter 1:10
  - particle counter
- does the Volatile Particle Remover (VPR) fulfill the requirements?



PMP required set-up

approach

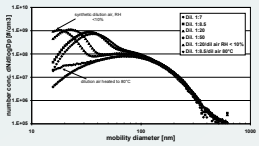
- dilute the particle sample to reduce volatile mass concentration
- dilution must reduce volatile mass concentration below dew point
- heat dilute sample to evaporate volatile particles
- upon cooling, not re-nucleation occurs, because mass concentration is too low



post-dilution thermo-conditioning

challenge

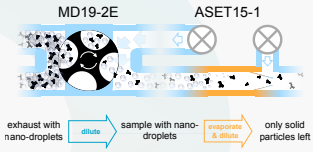
- in CVS tunnel, volatile material condenses to nanodroplets
- nanodroplets are a sampling artefact distorting the result
- droplet nucleation influenced by
  - dilution factor
  - temperature of dilution air
  - relative humidity of dilution air
- all of the above parameters are variable in CVS
- solid particles are not affected by sampling parameters



droplet nucleation during dilution

realisation

- use rotating disc diluter to reliably reduce concentrations
- heat the transfer tube (up to 400 ˚C) to evaporate volatiles
- apply secondary dilution to minimise thermophoretic losses



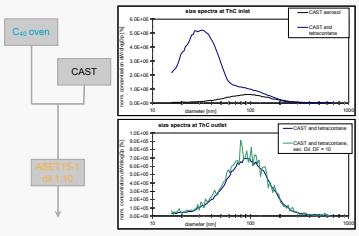
commercial solution

Matter Engineering models **MD19-2E** (rotating disc diluter) and **ASET15-1** (evaporation tube with secondary diluter)

front view *rear view*

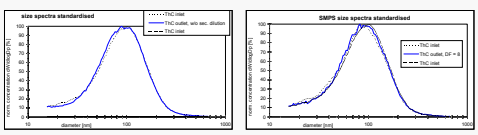
volatile particle removal: excellent

- model aerosol from CAST and tetracontane oven
- tetracontane concentration is 500 times higher than required by PMP
- complete removal of all volatile material



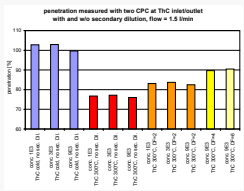
size dependence: none

- thermophoretic losses from upstream/downstream SMPS measurement
- CAST aerosol, approx. 2e+6 prt/cm³
- secondary dilution factor 1 and 8, respectively



concentration dependence: none

- 3 different concentrations of CAST aerosol: 1e+3 / 3e+3 / 9e+3 prt/cm³
- evaporation tube cold / heated to 300˚C
- secondary dilution factor 1 / 2 / 4 / 6



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