TPN and size evolution in DTT vs CVS

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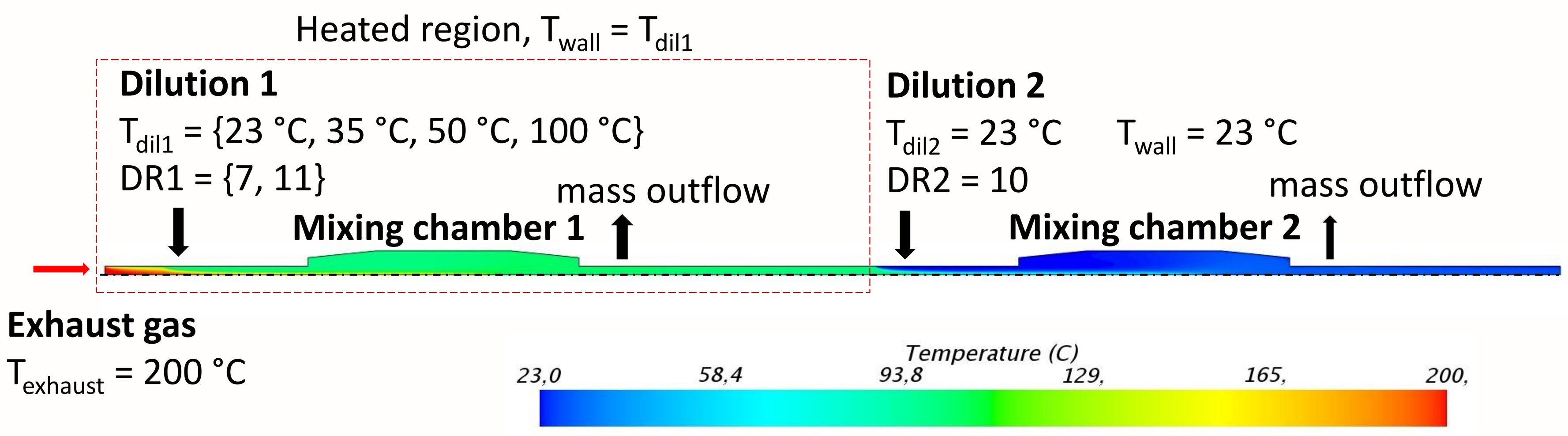
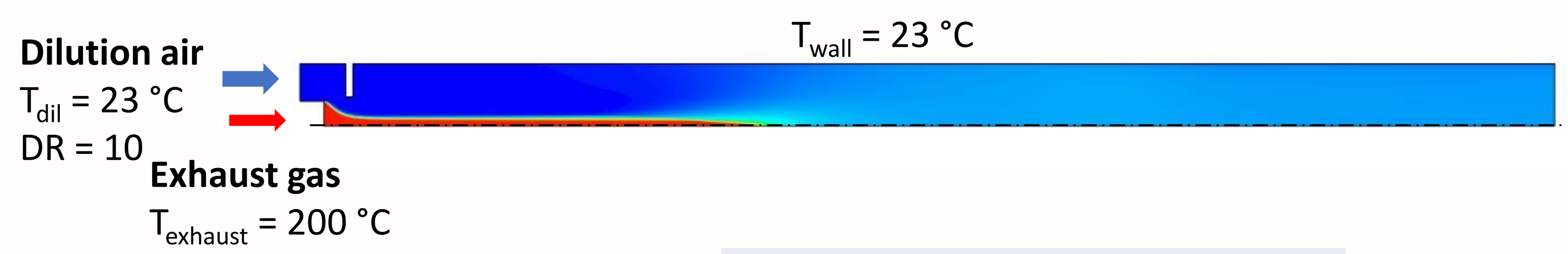
DOWN TO 10

Introduction

- Dilution conditions can significantly affect particle number emissions and size.
- A Multicomponent Modal Aerosol Model (MMAM) was developed and coupled with the CFD software STAR-CCM+ to simulate particle formation and growth in the DTT system and in the CVS. Three different components are included in the model (sulfuric acid, water, hydrocarbons). The modes considered are the volatile nucleation mode (liquid particles) and the soot mode (particles with a solid soot core). The aerosol processes simulated are :
  - Nucleation (sulfuric acid and water)
  - Condensation (sulfuric acid, water and hydrocarbons)
  - Coagulation (between volatile particles and between volatile and soot particles).
- Particle losses are considered through diffusion on the walls.

DTT and CVS setup

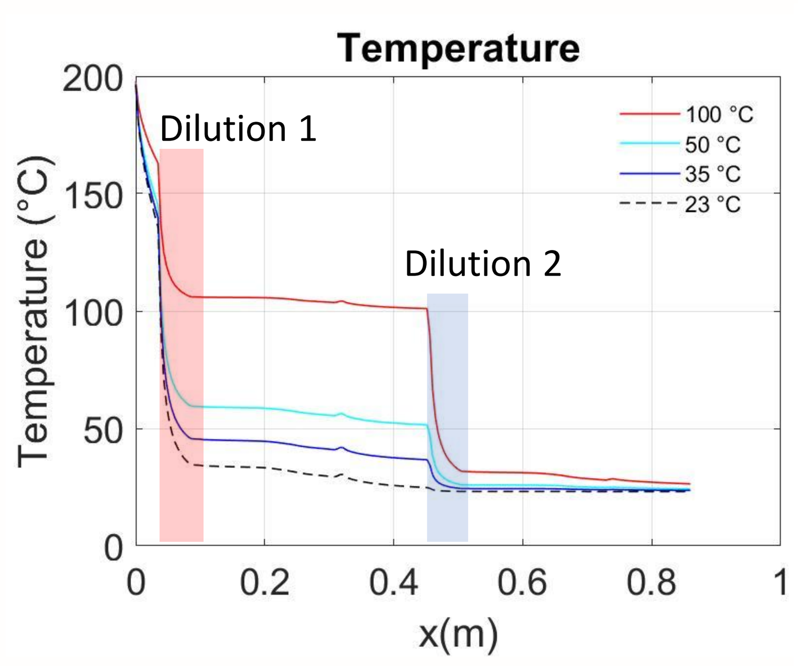


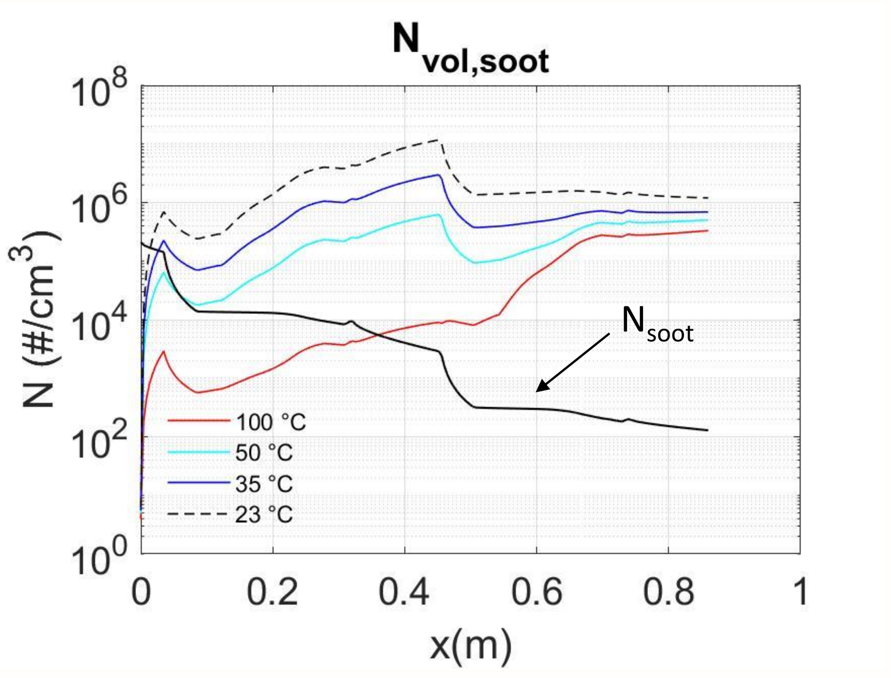


Same exhaust gas inlet conditions between DTT and CVS:

$N_{soot} = 2 \cdot 10^5 \ \#/cm^3$
$M_{soot} = 0.08 \ mg/m^3$
$C_{hc} = 3 \cdot 10^{-5} \ mol/m^3$
$C_{sa} = 5 \cdot 10^{-7} \ mol/m^3$
$C_w = 1.68 \ mol/m^3$

DTT system: effect of 1st dilution temperature on PN

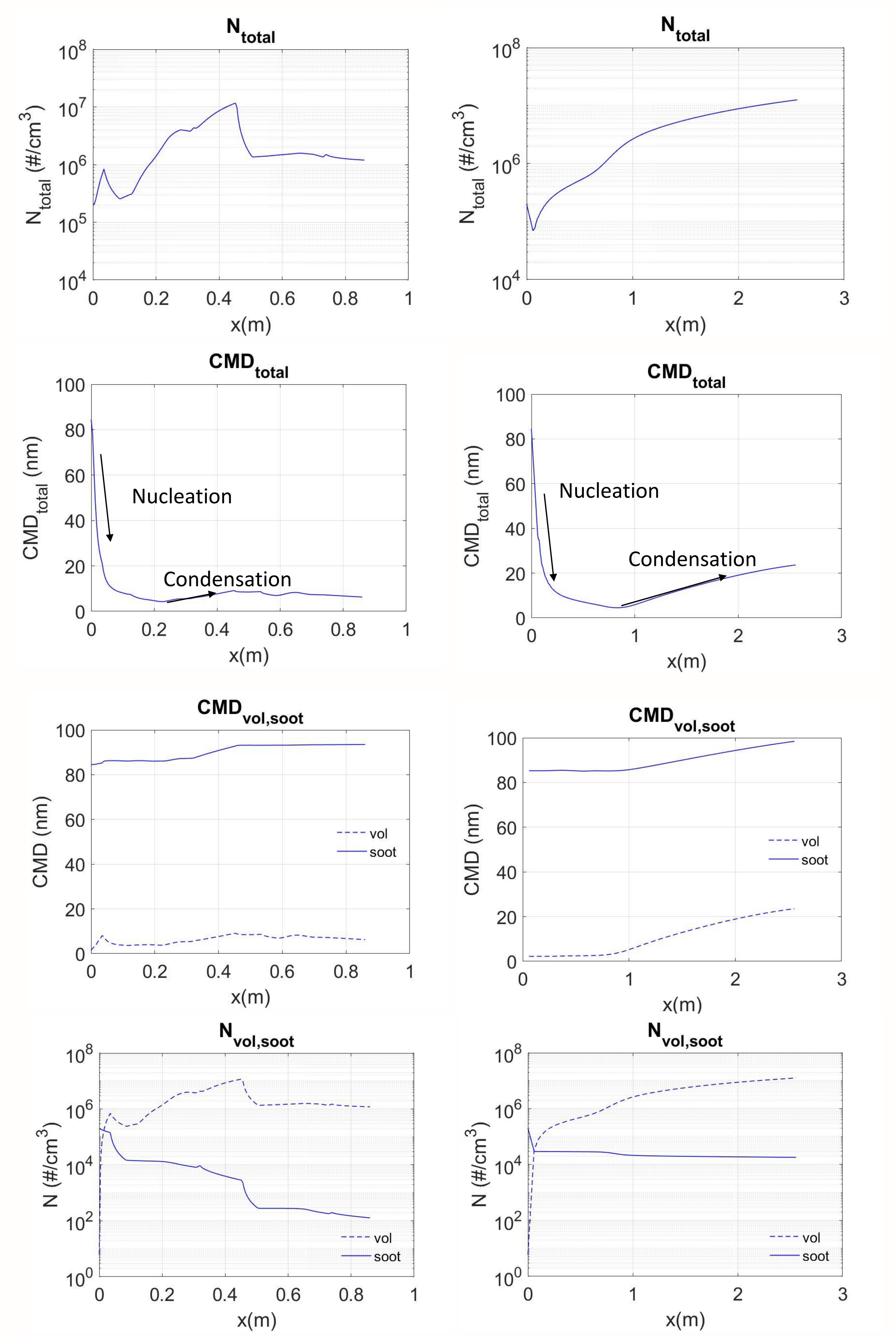




- Lower first dilution temperature results in higher volatile PN, while soot PN is independent of dilution temperature.
- After the first dilution and for T_{dil1} = 23 °C, volatile PN reaches values which are over three orders of magnitude higher compared to T_{dil1} = 100 °C (8.7×10^3 #/cm³ vs 1.1×10^7 #/cm³).
- At DTT outlet volatile PN for T_{dil1} = 23 °C is 3.6 times higher compared to T_{dil1} = 100 °C (3.3×10^5 #/cm³ vs 1.2×10^6 #/cm³).

Variation of PN and CMD for DTT vs CVS

DTT (T_{dil1} =23 °C, DR1=11, DR2=10)	CVS (T_{dil} =23 °C, DR=10)



Conclusions

- Similar values of total PN are observed at the CVS outlet (DR = 10, T_{dil} = 23 °C) compared to the corresponding values after the first dilution in the DTT (DR1 = 11, T_{dil1} = 23 °C).
- Total PN is dominated by volatile particles, as N_{vol} is more than 3 orders of magnitude larger than N_{soot}.
- Particles are larger at CVS outlet compared to DTT outlet, as higher residence time and gas species concentrations allow them to grow in size through condensation.

Future work

- Include hydrocarbons in the nucleation mechanism.
- Decouple condensation of water from the condensation of sulfuric acid.
- Validation of the aerosol model with engine exhaust aerosol measurements.

PROJECT PARTNERS

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