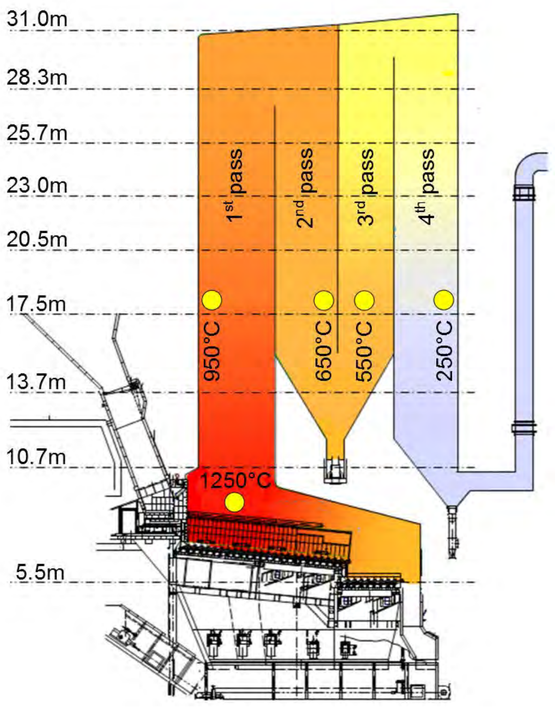
Particle sampling in boilers of waste incineration plants: Development and characterisation of a novel probe

S. Schumacher[1], J. Lindermann[1], B. Stahlmecke[1], T. Zeiner[1], T. van der Zwaag[1], H. Nordsieck[2], R. Warnecke[3], C. Asbach[1]

[1] Institut für Energie- und Umwelttechnik e.V. (IUTA), Duisburg, Germany
[2] bifa Umweltinstitut GmbH, Augsburg, Germany
[3] GKS Gemeinschaftskraftwerk Schweinfurt GmbH, Germany

Motivation



- high-temperature corrosion in boilers of waste incineration plants
  → high material consumption, reduced availability, limited efficiency
- supposed primary reason: chlorine-containing microparticles (approx. 1 - 25 µm diameter)

Previous approach [1]

- dilution and cooling + aerosol measurement
- two major disadvantages
  → deposition of sticky particles in the gooseneck inlet
  → condensation of salt vapours during cooling

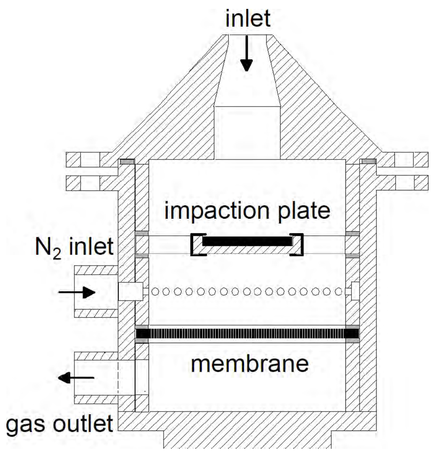
[1] Deuerling et al. (2010): *Aerosol Sci. Technol.* **44** 1

Requirements for a new method

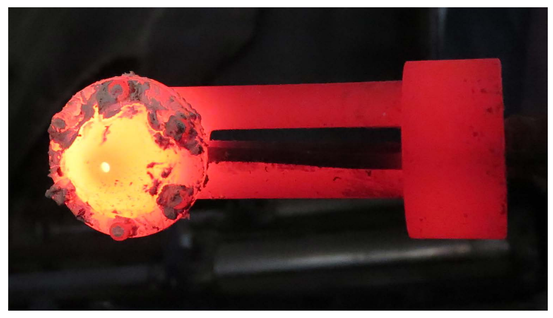
- well-defined collection of sticky microparticles
- prevention of artefacts by condensation
- high temperature and corrosion stability
- best possible isokinetic sampling
- suitable for 50 mm ports in the boiler wall

Construction of the probe

- two-stage system for particle collection
  1. impaction plate made of corrosion-resistant steel
  2. nickel membrane with 10 µm pore diameter [2]
- before and after sampling flushing with nitrogen excess
  → suppression of condensation and reactions
  → facilitation of well-defined sampling times



probe mounted on the holder



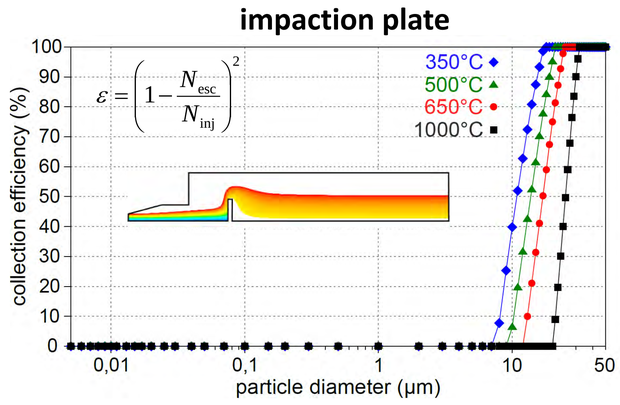
probe after usage at 1250°C

[2] produced by galvanic deposition at the Fraunhofer institute UMSICHT (Oberhausen)

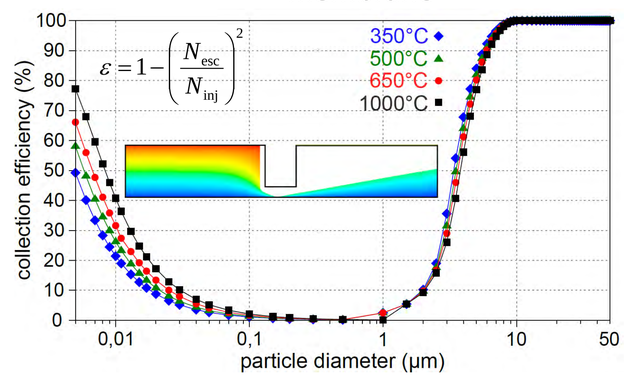
Collection characteristics

- CFD simulations (two-dimensional, rotationally symmetric)
- consideration of impaction, interception, and diffusion
- results of the simulations
  - efficient collection of microparticles
  - impaction plate shields membrane from larger particles

impaction plate

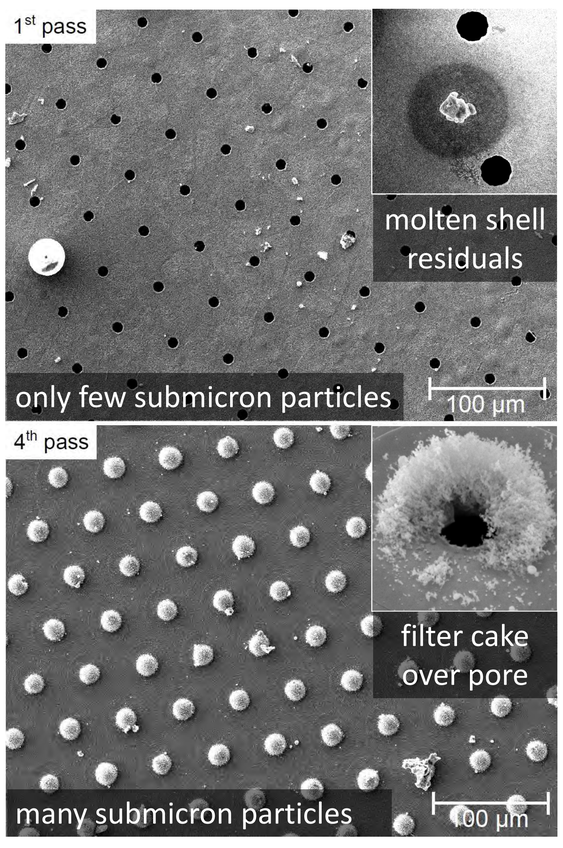


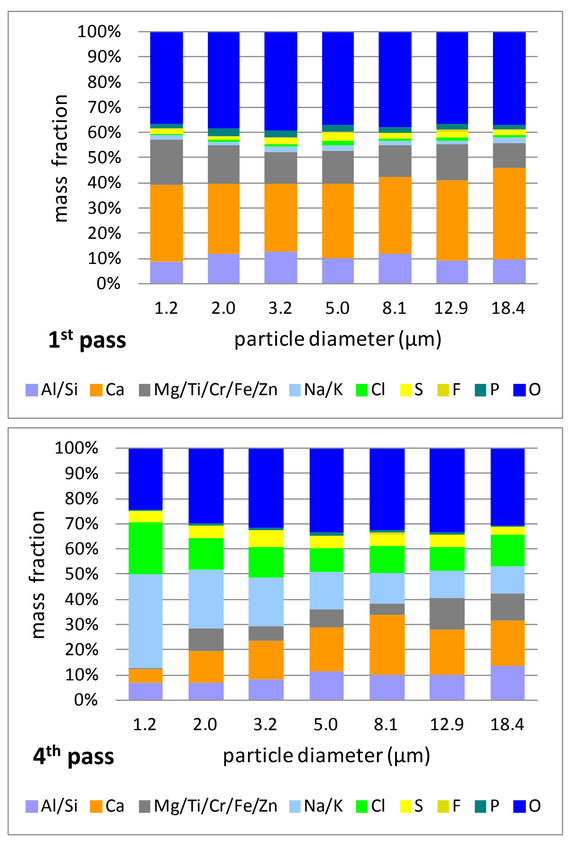
membrane



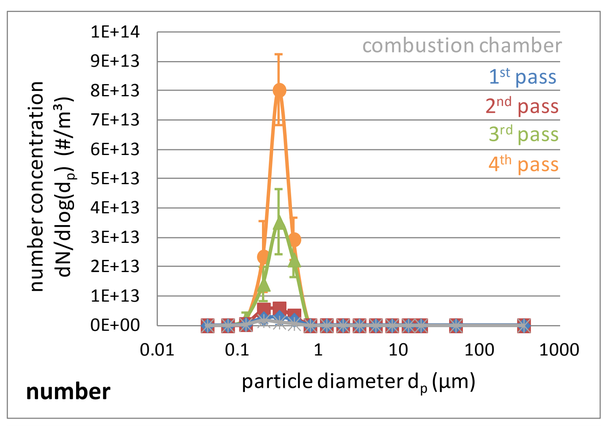
First results

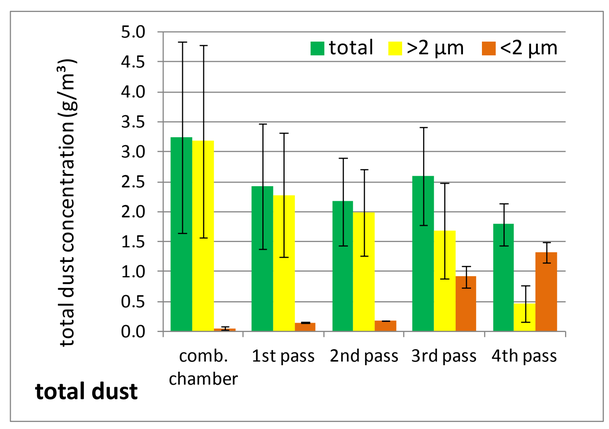
Particle morphology and chemistry (exemplarily for 1st and 4th pass)

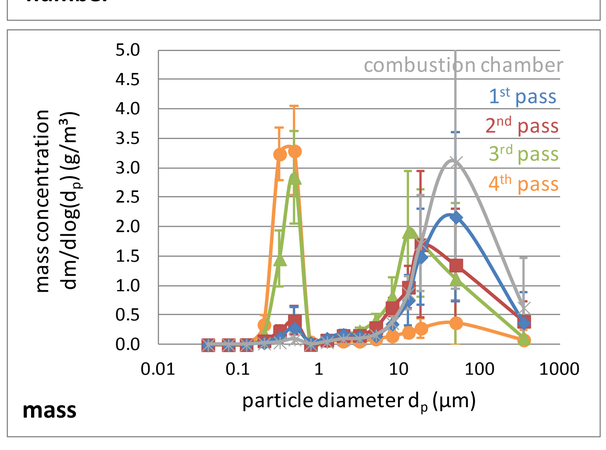




Number/mass size distribution and total dust concentration







During the course of the boiler

- increasing amount of small particles due to condensation of salt from the gas phase
- decreasing amount of larger particles due to deposition

Summary

- efficient collection even of sticky microparticles
- single particle chemistry/morphology accessible
- artefacts by condensation largely suppressed
- outlook: measurements at further plants

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