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Stability of the combustion aerosol standard CAST

CAST - Combustion Aerosol Standard
Short Specifications, Applications

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Matter Engineering AG

Abstract

Calibration of gas measuring devices is usually accomplished by feeding them probe gas of known concentrations. The probe gas is stored in bottles for weeks or months and is eventually refilled. For particles this route is not viable because particles in gas suspension are unstable systems. Unlike gas molecules, colliding particles stick to each other, thus forming larger, but fewer, aggregate particles. Therefore, an aerosol for calibration purposes must be freshly produced each time it is needed.

A new instrument for the generation of combustion aerosol - the Combustion Aerosol Standard, CAST - developed at the Swiss Office of Metrology (METAS) is now being tested for stability and reproducibility of concentration and size of the produced particles. The CAST generates particles with a laminar diffusion flame. By adjusting the gas flows of fuel, oxidant and quench gas, the particle size can be varied in a range of 20..200 nm. Particle concentrations of up to 10^9 cm^{-3} or 40 mg/m^3 can be achieved.

The present paper shows the specifications of CAST and lists possible applications to which the specified properties are relevant. The last section presents results of an evaluation campaign at the AVL/Graz laboratories. Compared to a diesel engine, CAST offers major advantages as a particle source: especially at low concentrations (which imply low load for the engine) CAST is much more stable, and the particle size is variable. Owing to these properties the high sensitivity and accuracy of an AVL smoke meter even at very low concentrations (FSN = 0.020) could be demonstrated.

ETH Nanoparticle Workshop, 6th August, 2001 M. Kasper, E. Schiefer, W. Schindler: CAST

CAST - Combustion Aerosol Standard

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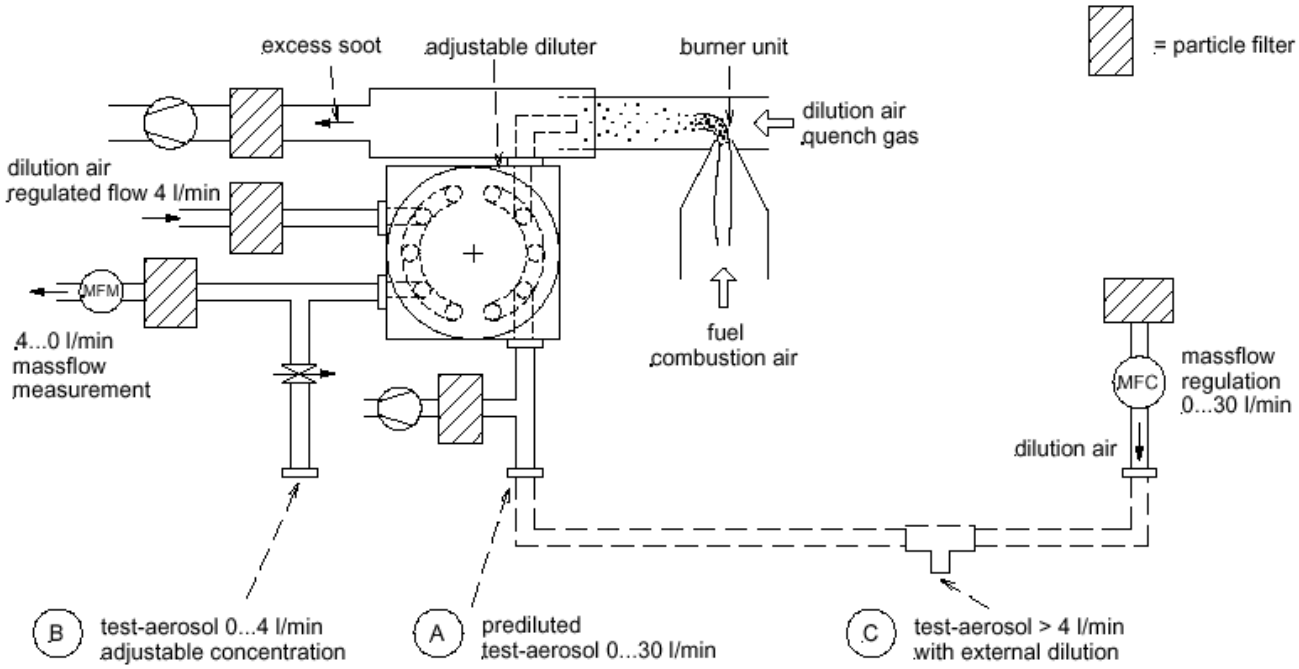
Specified Particle Properties

- particle mass concentration (PM)
- elemental carbon (EC) / organic carbon (OC) mass concentration
- number concentration
- mobility diameter
  monomodal/biomodal distributions
  adjustable modes from 20 ... 200 nm
- active particle surface
- fractal properties similar to diesel soot particles
- in preparation: gas-concentrations for HC, CO, CO2, ...

CAST Principal Diagram



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Specifications for prediluted test aerosol A

Soot particles from burner unit, prediluted over dew point

- adjustments: Selection of discrete modes in the mobility diameter range 20 ... 200 nm
- mass concentration 8 ... 40 mg/m^3 depending on selected mode
- number concentration 10^8... 10^9/cm^3 depending on selected mode
- sample flow up to 30 l/min

Applications for connection A - prediluted test aerosol

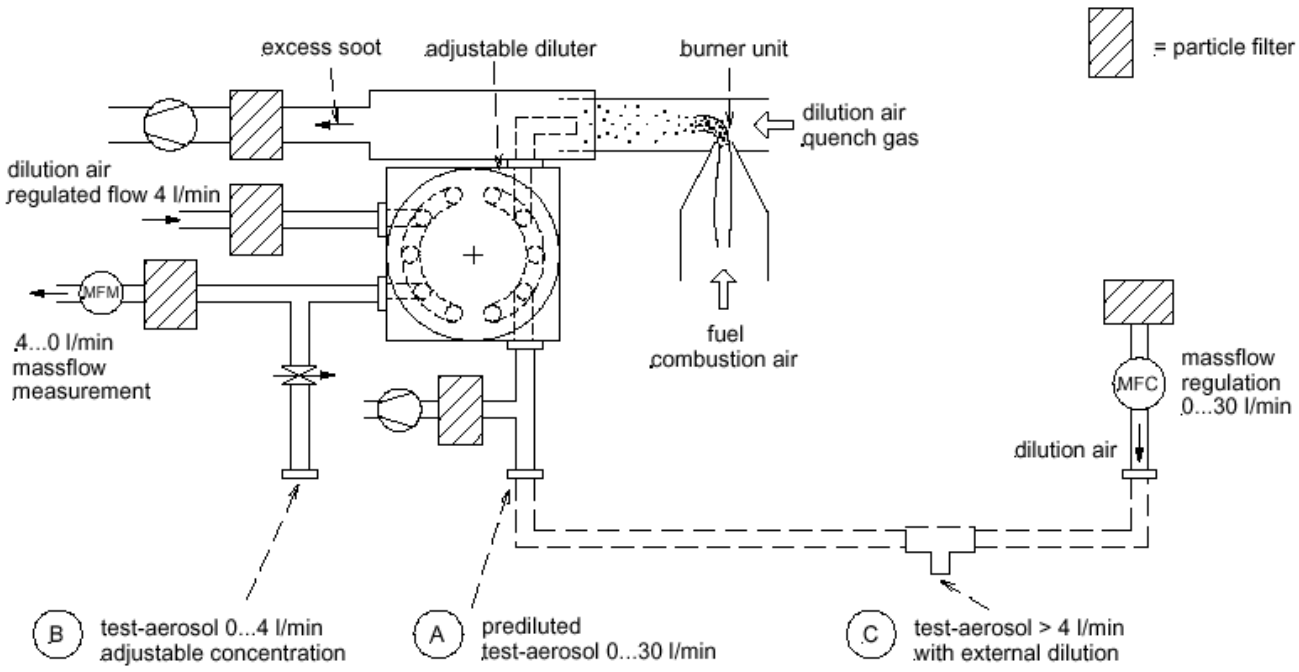
Features

- high number concentrations from 10^8... 10^9/cm^3
- sample flow 0 ... 30 l/min

Applications

- calibration of filter analyzing methods
  (coulometric carbon alalysis, gravimetric mass analysis)
- calibration of measuring instruments
  for particle emissions on reproducibility
  - opacimeter
  - Bosch / Bacharach smoke number
- influence of particle size on these measuring methods
- particle size dependent precipitation of filter material

CAST Principal Diagram



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Specifications for diluted test aerosol B

Additional continuously adjustable dilution for prediluted test aerosol

- on 10-turn potentiometer, corresponding concentrations are displayed
- on PC by selection of requested concentration or dilution factor
- mass concentration 0 ... 0.7 mg/m^3
- number concentration 0 ... 10^7/cm^3
- sample flow 0.2 ... 4 l/min, measured by CAST

Applications for connection B
- test aerosol from adjustable dilution

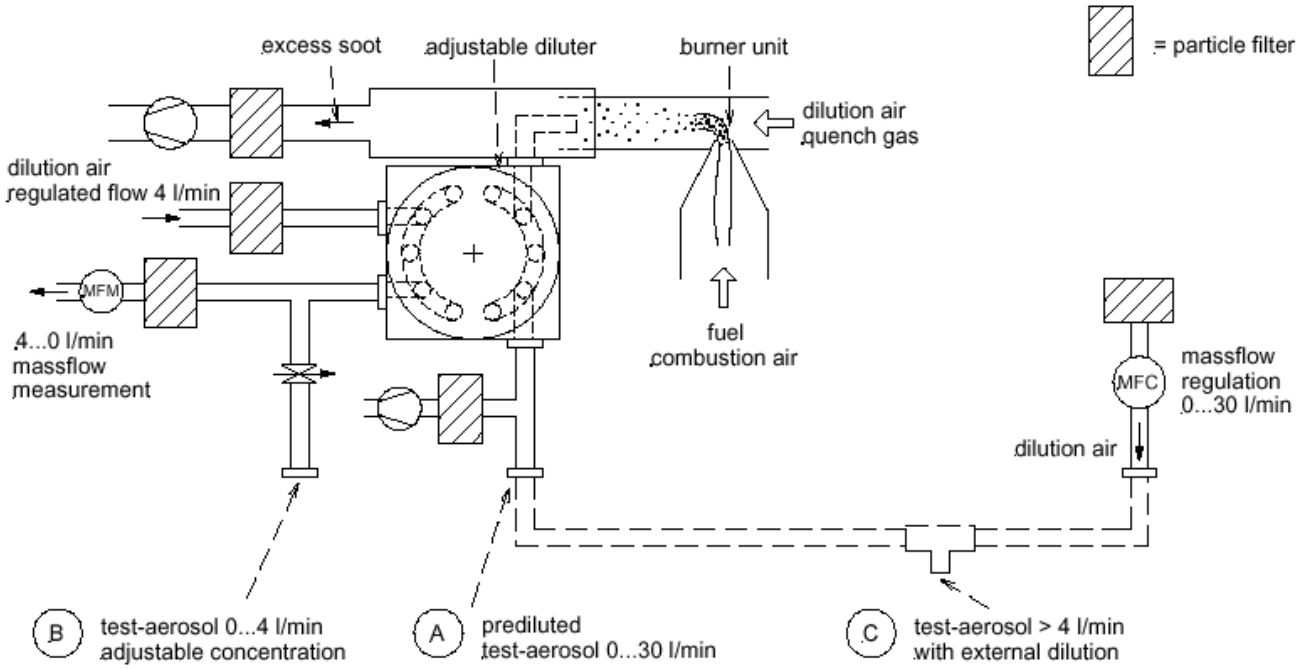
Features

- adjustable concentations 0 ... 10^7/cm^3
- sample flow 0 ... 4 l/min
- fine adjustment valve for pressure compensation in sample flow (SMPS)

Applications

- calibration of online particle sensors and measuring systems
  - condensation particle counter (CPC, number)
  - scanning mobility particle sizer (SMPS, size, number)
  - diffusion charging sensor (DC, active surface)
  - epiphaniometer (active surface)
  - aethalometer (BC, black carbon)
  - light scattering sensors (mass, size)
  - betameter (Mass)

CAST Principal Diagram



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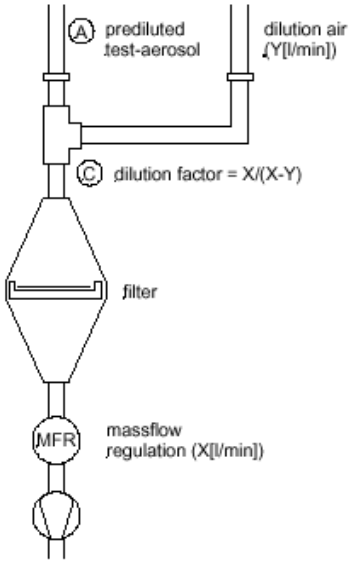
External Dilution C

Mass flow regulated dilution air, range 0 – 30 l/min for

- dilution of prediluted test aerosol A
  to adjust its requested mass concentration
- additional dilution of the diluted test aerosol B
  to increase the sample flow above 4 l/min

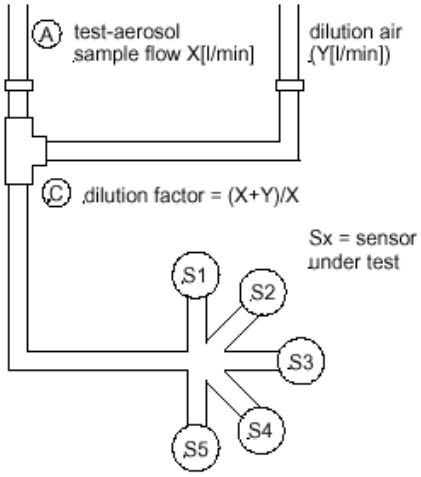
Appliciations with additional external dilution C

prediluted test aerosol from gas connection A



Adjustable concentrations
For filter analysis

test aerosol with adjustable dilution from gas connection B



Sample flow > 4 l/min for
- round robin tests
- ELPI

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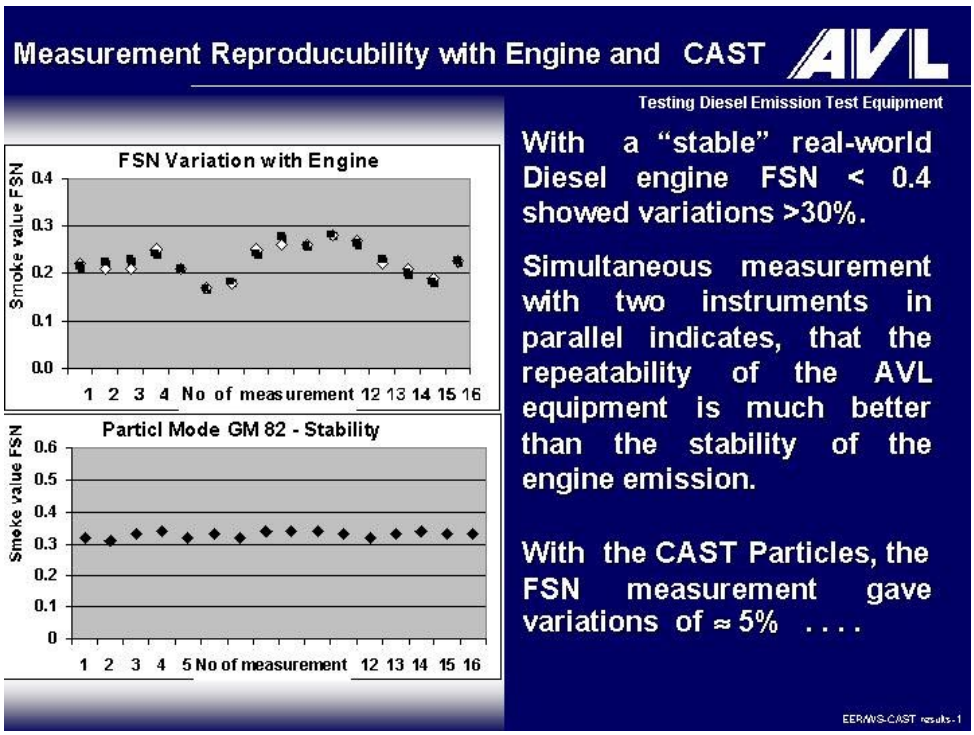

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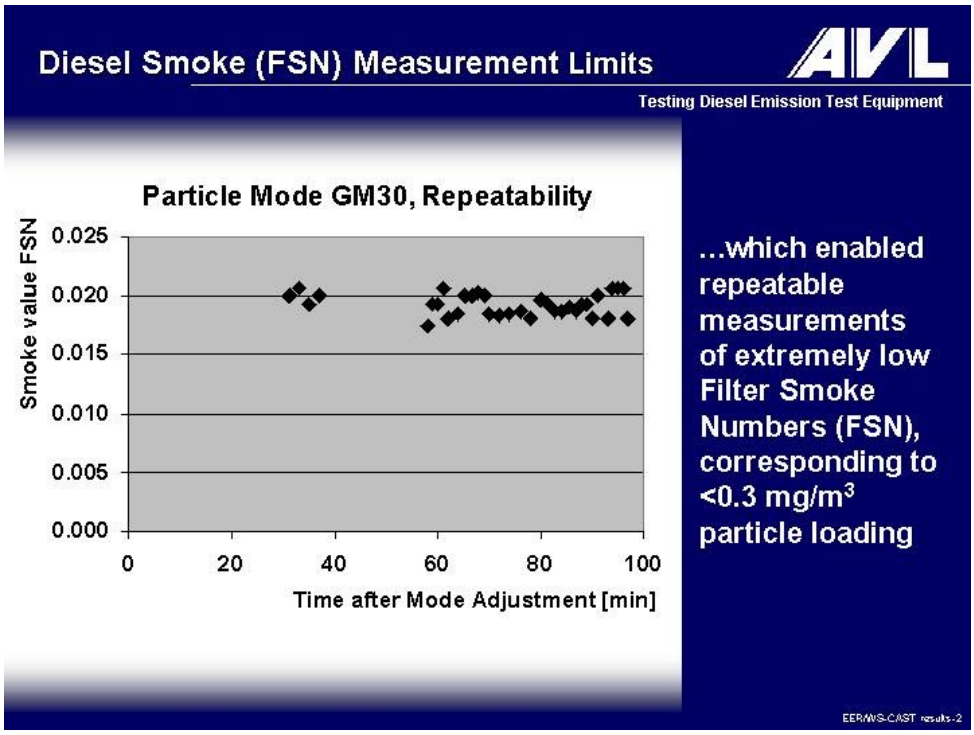

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