Investigation of the Flow Characteristics of in Aerosol Mixing Facility

S. Horender[1], K. Auderset[1], K. Vasilatou[1]

[1]METAS, Bern, Switzerland

Abstract

The measurement and regulation of particulate matter to improve outside air quality advanced a lot over the last decades. This also made it necessary to develop primary standards for calibrating these measurement systems and in future the composition of relevant aerosols will be taken into account. METAS has a facility to create an air flow of 180 l/min homogeneously laden with different types of aerosols, and from this flow aerosol laden air is sampled and led to different particle measurement systems to be calibrated or compared. This facility is a 4 m long pipe, which has a central aerosol injection and then three concentrically arranged mixing jets to homogenize the aerosol loading. Details will be presented in the talk and the paper.
Measurements of the homogeneity of the aerosols concentration showed that 2.4 m downstream of the aerosol injection the distribution was homogeneous within 3%.
The flow field has been modeled by the COMSOL Multiphysics® CFD module by using the symmetry of the geometry so that only half of it had to be meshed. Since the Reynolds number of the flow is around 1800, turbulence has to be taken into account. Comparisons of the CFD results with measured velocity profiles using Laser Doppler velocimetry showed that a low-Reynoldsnumber k-epsilon model that resolves the flow up to the wall (no wall functions) was appropriate to get the velocity characteristics of the pipe flow part. Figure 1 shows the velocity profile close to the exit of the pipe, where the aerosol is extracted to the different measurement devices.
The mixing itself has been predicted using the dilute species transport node and this performed less well, probably because the details of the mixing jets were not represented appropriately. Therefore, currently detailed simulations of the interacting jets responsible for the mixing are performed to get further insight into the mixing process and also a better agreement with measurements of the mixing characteristics.
The impact of the above findings with respect to a novel facility that will make use of a more realistic aerosols mixture of dust, soot and salt and organic substances finally will be discussed and simulations for possible designs will be presented.

Figures used in the abstract

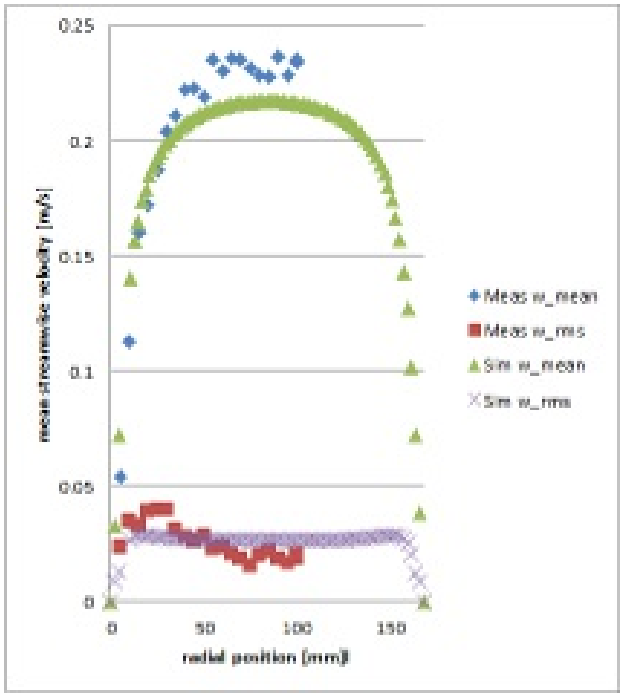

Figure 1: Computed and measured cross-stream profile of streamwise mean and rms velocity in the aerosol mixing tube.