S1.5.1 - *On the Spatio-temporal Particle Emission Behavior of Pulse-jet Cleaned Surface Filters via Measurement of the Emission Contribution of Individual Filter Bags with Low-cost Particulate Matter Sensors*

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Protection of the environment from dust emissions plays a key role in a variety of technical processes. Primarily the cement industry or the energy sector, where high dust concentrations have to be separated from loaded gas streams, rely on pulse-jet cleaned surface filters in order to meet emission standards. Emission monitoring of baghouse filters is oftentimes only scarcely implemented, as only a total dust emission is measured, if at all. However, particle emission hotspots like leaks, damaged filter media, or incorrectly installed bags can contribute significantly to the total dust emission. Identifying such hotspots via online measurement could greatly help plant operators regarding filter maintenance and operation strategy. Low-cost particulate matter sensors, which gained in popularity over the last decade for the application of air quality monitoring, are suitable for spatial deployment in filter houses and offer the possibility for local and simultaneous measurement of the dust emission. The potential for spatially resolved online measurement was shown in a pilot plant scale baghouse filter with nine filter bags, whereby the local particle concentration at the outlet of each filter bag has been monitored applying a commercially available low-cost particulate matter sensor from the manufacturer Alphasense. The qualitative emission behavior of the local particle emissions detected via low-cost sensors and the total particle emission detected by a highly developed aerosol spectrometer from the manufacturer Palas® correspond well. During the initial filtration cycles, a high continuous particle emission occurs. This continuous emission decreases over time, indicating the clogging of the seams of the filter bag, until an ideal emission behavior similar to filter test rigs occurs (no continuous baseline emission). Here, the particle emission peaks after jet-pulse cleaning of the corresponding filter bag are detected by the locally installed low-cost sensor only and can be clearly allocated to an emission peak of the total dust emission detected by the reference. During consecutive filter operation, a continuous particle emission in addition to the emission peaks due to filter regeneration may reappear and/or disappear at individual filter bags. At higher pulse intensities, this cycle dependent continuous emission occurs with higher frequency and higher intensity and likely originates from the release of particles from the (previously) clogged seams of the filter bag due to jet-pulse cleaning. Furthermore, local measurement enables the identification of particle emission hotspots and different spatial emission levels on the clean gas side, which were generated by installation of filter bags with different properties (e.g. permeability, surface treatment). In addition to concentration monitoring, the particle size distribution on the clean gas side also varies between the filter media and can be distinguished by the data obtained from low-cost PM-sensors, further demonstrating the potential for the improvement of emission monitoring in filtration applications.

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Peter Bächler studied Process Engineering and Energy Technology at the University of Applied Sciences Bremerhaven. After gaining his Master's degree, he started his Ph.D. at the Institute of Mechanical Process Engineering and Mechanics under the guidance of Prof. Dr.-Ing. habil. Achim Dittler at Karlsruhe Institute of Technology. After working two years in the field of pulse-jet-cleaned surface filters, Peter published two journal papers about the suitability of low-cost PM-sensors for filter emission measurement, attended several technical conferences and gained first experiences regarding the review of scientific articles.

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