Influence of humidity and temperature on bag filter performances for incineration fumes treatment

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There is no French or European regulation on the management of manufactured nanomaterials, whatever manufacturing, use or end of life is concerned. Such nano-containing products or nano-waste can end up in incineration plants.

The aim of this study was to evaluate the performances of incineration fumes treatment, more especially particle removal efficiency focusing on bag filters technology. For that purpose the performances of a bag filter prototype were evaluated during several clogging/unclogging cycles with a submicron aerosol. The influence of gas temperature and humidity on changes in filtration efficiency and pressure drop were studied for two operating conditions: incineration conditions i.e. 150°C and 3% of relative humidity (RH) and ambient conditions i.e. 24°C and 45% RH. For both operating conditions, filtration velocity was 1.9 cm/s. The experimental set-up for single bag filter was described by Tran *et al* (2014). The aerosol used for clogging was a condensation aerosol generated from graphite monoliths (generator DNP 2000, Palas) whose particle size distribution was characteristic to those emitted from the incineration of black carbon nano-waste in a lab-scale oven (Tran *et al*, 2014). Filtration efficiency was quantified from particle sampling up and downstream of the bag filter throughout the clogging/unclogging cycles and counting with SMPS (Grimm) or ELPI (Dekati). The maximal bag filter pressure drop was set to 120 Pa and 150 Pa in ambient and incineration conditions respectively for all filtration cycles; once it was reached the filter was cleaned by on-line pulse jet method.

Figure 1 shows the increase of bag filter pressure drop as a function of time for 10 clogging/unclogging cycles at ambient conditions. In accordance with Park *et al* (2012), the experimental results confirm that the clogging time period of the filtration cycles decreases from the first cycle (1090 min) to the last one (62 min). In terms of minimum pressure drop, the baseline which corresponds to the measured pressure drop (ΔP) just after cleaning increases with filtration cycles. This increase (from around 20 to 80 Pa) is due to the residual particulate cake or in-depth particles onto the bag from previous filtration cycles. Similar results were observed at incineration conditions but kinetic of clogging/unclogging was different.

The evolution of bag filter efficiency versus particle diameter for different levels of clogging (ratios ΔP/ΔP0 with ΔP0 the initial filter pressure drop of cycle 1) during the first clogging cycle is presented in Figure 2. The results indicate that the minimum particle collection efficiency was 91%. The results also reveal, in accordance with filtration theory, an increase in particle collection efficiency with the filter clogging. The most penetrating particle size (MPPS) value is not observable for the size range studied at ΔP/ΔP0=2.7, but decreases from 90 nm for ΔP/ΔP0=5.6 to 60 nm for ΔP/ΔP0=7, suggesting in particular a possible increase of particle collection by the diffusion mechanism with clogging. For higher level of clogging (ie from ΔP/ΔP0=9) particle collection efficiency reaches almost 100% whatever particle diameter. The results were compared with those obtained in incineration conditions which revealed in particular higher filtration efficiency during the first clogging/unclogging cycle.

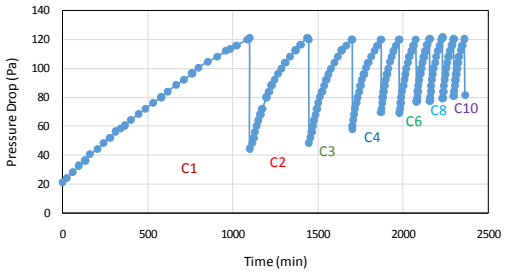

Figure 1. Pressure drop across bag filter versus time for 10 clogging/unclogging cycles at ambient conditions.

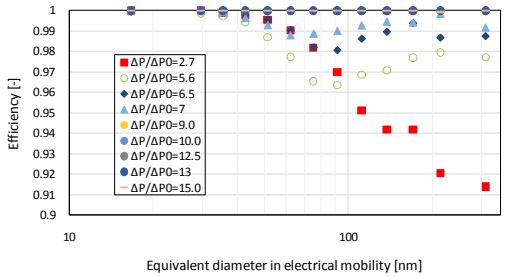

Figure 2. Fractional efficiency as a function of particle diameter at different values of ΔP/ΔP0 for the first filtration cycle at ambient conditions.

Park, B.H. *et al* (2012) *Aerosol and Air Quality Research 12: 1030–1036.*

Tran., D.T. *et al* (2014) *Proceedings of the 29th Congrès Français sur les Aérosols, Paris*.