Filtration of an ultrafine aerosol produced by thermal spraying using a granular bed

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Industrial filtering installations currently experience major problems associated with the treatment of the ultrafine particles produced by thermal spraying processes due to their high clogging properties (Bémer *et al*, 2013).

Granular beds allow ultrafine particles to be collected, by different mechanisms like brownian diffusion, (Ozis *et al*, 2004), electrostatic forces (Tardos *et al*, 1983), etc. The performance of granular beds have formed the subject of numerous studies, but mainly based on their initial state characterisation. However, variation in their performance characteristics during clogging (Kuo *et al*, 2010), i.e. based on particle accumulation within the bed, has been much less studied, especially in the submicronic particle size range. The aim of this study is to establish the variation in filtration efficiency and pressure drop ΔP of a granular bed during clogging by an ultrafine aerosol generated by an electric arc-based metal thermal spray gun (Zn/Al wire), and to evaluate the performance of a technique of ΔP regeneration by shocks .

The studied aerosol is characterised by a number concentration of 7.10^{8} cm^{-3} and a mass concentration of 90 $mg.m^{-3}$ and a mean aerodynamic mass diameter of 110 nm (Elpi measurement, Dekati[R]).

The experimental set-up, consists of a tubular granular bed 39 mm diameter, composed of three stages 11 mm long, followed by a 10.5 cm long stage. Each stage, supported by a metal grid, is filled with 0.695 mm diameter glass beads with a bed packing fraction of 0.615.The mass of glass beads was 21 g per stage and 200 g for the last one. Each stage was fitted with static pressure outlets for monitoring the pressure drop during clogging. The particle-laden air is supplied from the top of the column at a flowrate of 5 $l.min^{-1}$. At the end of the clogging phase, a series of shocks was applied at a frequency of 50 Hz to the outside wall of the first stage using a small vibrating device.

The evolution of ΔP of the three stages (11 mm long) during four clogging/unclogging cycles is presented in Fig.1. Stage 1 gradually clogs and its efficiency increases, thereby reducing the particle flow to the lower stages 2 and 3, and curtailing the increase in ΔP. This experiment shows that particle accumulation mainly occurs within the first centimetre of the column, which mainly controls the ΔP within the whole system during clogging.

The granular bed mass efficiency E, defined by the ratio of the mass retained by the mass entering the column was 97.5 % ± 0.4 from the first to the fourth cycle.

As it can be seen in Fig.1, the ΔP of the three stages recovers its initial value after unclogging. The shocks technique experimented in this study appears really promising but should be tested with more clogging/unclogging cycles for validation purposes. Furthermore, checking that the unclogging process does not lead to particle emission as often observed in pulse-jet cleaning of filter media should also be undertaken.

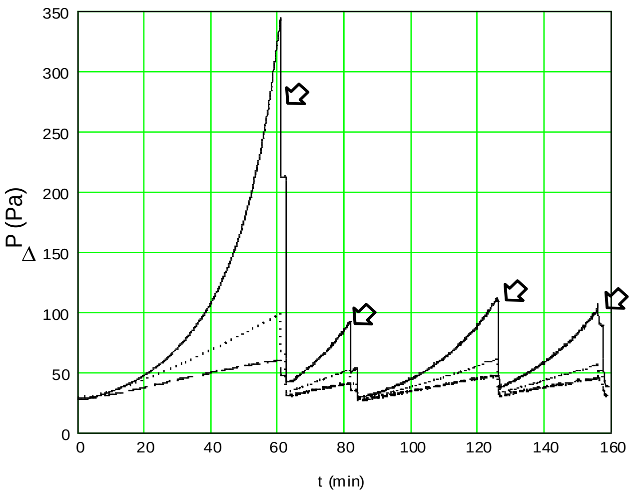

Figure 1. ΔP variation of the three 11 mm long stages during four clogging/unclogging cycles. — stage 1, …. stage 2, ---- stage 3.

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