Trickle bed applied to the treatment of blast furnace dust

Guillemette Thieffry[1-2], Augustin Charvet[1-2], Nathalie Bardin-Monnier[1-2], Dominique Thomas[1-2]

[1] Université de Lorraine, Laboratoire Réactions et Génie des Procédés, UMR 7274, Nancy, F-54000, France
[2] CNRS, Laboratoire Réactions et Génie des Procédés, UMR 7274, Nancy, F-54000, France
Keywords: Aerosol, Dust separation, Filtration, Trickle bed
Presenting author email: guillemette.thieffry@univ-lorraine.fr

For a long time, steel industry is responsible for high emissions of CO_2. With a view to reduce these emissions, the VALORCO project proposes to reduce at source the quantity of CO_2 and to value that emitted. The valorization solutions require a gas free from particles or at least with a very low dust content and consequently the adding of a new step in the treatment chain in order to decrease particle concentration. With that objective in mind, a trickle bed filter is developed to treat high flow rates with a good collection efficiency and a limited and constant pressure drop. This technology is a combination between a granular bed and an absorption column, in which the particles trapped on collectors are continuously re-entrained thanks to a water film flow. However, the main difficulty in the design of the separator is the selection of the operating parameters and the characteristics which permit to obtain a good efficiency (as close as possible to a filter media efficiency) while maintaining a constant and limited pressure drop. As there is no correlation for determining the theoretical collection efficiency and pressure drop of a trickle bed, the performances of this separator have been compared with those of a traditional granular bed.

The experiments have been carried out in a co-current configuration on a 2.5 m-high glass column with a diameter of 0.2 m. The bed is 0.5m high and different collectors have been used (glass beads and Raschig rings). An aerosol composed of Al_2O_3 micronic particles is generated and collected through the granular bed. Water is pumped from a tank and a distributor is used to homogeneously wet the collectors. To evaluate the performances of the filter, a pressure transducer records the pressure drop into the column and an aerodynamic particle sizer allows measuring the upstream and downstream airborne particle concentrations in order to calculate the filtration efficiency.

The pressure drop was measured for different air and water flows. The gas and the liquid flow rates varied from 10 to 22 $m^3.h^{-1}$ and from 4 to 20 $L.min^{-1}$, respectively. This hydrodynamic study highlights that the pressure drop increases when the collector diameter decreases. This is in accordance with the literature (Kuo *et al* 2010). Moreover, for given collector size and air flow rate, the pressure drop increases with the water flow. This is due to the presence of water through the column which decreases the bed porosity. However, even if it is higher than for a dry granular bed, the pressure drop remains acceptable.

Initial collection efficiencies of this trickle bed were determined for various beads diameters and liquid flow rates and a constant air flow rate, set at 20 $m^3.h^{-1}$. The results show that the initial collection efficiency increases if the collector diameter decreases. This is in accordance with the results obtained by Kuo *et al* (2010) and Saxena *et al* (1985) on dry granular beds. It could also be noted that the initial collection efficiency increases with the water flow. This phenomenon reveals that the addition of a water film flow improves the filter performances. Finally, filter clogging experiments have been performed. While the collection efficiency of the separator was almost constant in presence of water, the pressure drop was clearly higher at the beginning of the experiment, but it tended to stabilize over time, around values well below to those observed for a dry granular bed (see Figure 1).

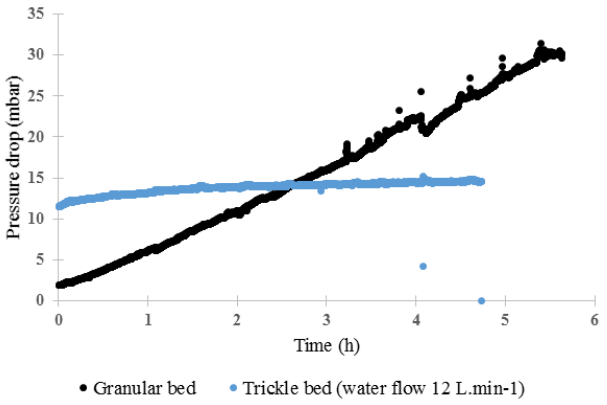

Figure 1. Pressure drop in clogging experiment for a granular bed and a trickle bed (glass beads collectors with a diameter of 5 mm)

To conclude, this study aims to develop a trickle bed in order to treat high flow rates with a good collection efficiency and a limited and constant pressure drop. The first experimental results validate our approach of using a trickle bed, revealing a good initial collection efficiency and a constant and low pressure drop in comparison to a dry granular bed.

The authors are grateful to the French Environment and Energy Management Agency (ADEME) for financial support for VALORCO Project (agreement no. 1382C0246).

Kuo, Y.-M., Huang, S.-H., Lin, W.-Y., Hsiao, M.-F. and Chen, C.-C. (2010) *J. Aerosol Sci.* **41**, 223–229.

Saxena, S.C., Henry, R.F. and Podolski, W.F. (1985) *Prog. Energy Combust. Sci.* **11**, 193–251.