Study of filtration performances of fibrous media: comparison between flat and industrial-geometry prototypes filters

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In recent years, great consideration has been paid to indoor air quality (IAQ) and its influence on health of buildings occupants, especially because people in industrial countries stay almost 80% of their time in enclosed spaces (Gustavsson, 2010). Ventilation systems contribute to IAQ supplying fresh air, limiting outdoor pollutants and evacuating indoor contaminants such as aerosols. Air cleaning technologies are often coupled with ventilation systems for improving IAQ such as filtration with fibrous media for particles removal from air. Filtration performances of fibrous media have been studied basically in laboratory using flat filters (Novick et al., 1992; Walsh, 1996). Nevertheless, filters in Air Handling Units (AHU) have different geometries to optimize the efficiency to pressure drop ratio such as bag and pleated filters. A lack of knowledge is remaining about evolution of performances during clogging of this type of filters regarding pressure drop and efficiencies. Time of life of these filters is uncertain and they are replaced periodically without estimation about their performances.

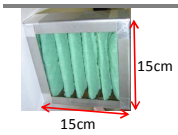
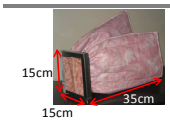
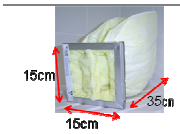
The aim of this study is to predict the performances variation of industrial filters during clogging in comparison with flat filters. This could help to understand aerosols behaviour on fibrous filters with different geometries typically used in AHU having into account their efficiency and pressure drop which could be extrapolated to an economic point of view.

First of all, a laboratory-scale Air Handling Unit AHU has been developed to realize the clogging of filters with solid aerosols. It is a closed-loop vent through which air can be continuously circulated at controlled and regulated temperature (T) and relative humidity (RH). Symmetric velocity profiles were found upstream of the filter. Prototypes filters of different efficiencies (G4 to F9 according to European standard EN13779) and industrial geometries (bag and pleated filters) are tested at a characteristic air filtration velocity of real AHU (0.1-0.9 $m.s^{-1}$). Filters performances during the clogging are estimated with particles counting upstream and downstream of the filter (optical particle counter PALAS Welas) as well as pressure drop is monitored.

Two typical industrial geometries and materials of filters used in AHU, as well as flat filters, are studied: fibre glass-bag filters and cotton/polyester-pleated filters (Table 1). Aluminium oxide (Al_2O_3) commercial dust was selected to clog the filters because of its size distribution close to PM10 ambient urban aerosols.

A dust generator RBG1000 PALAS is used for particles dispersion into the pilot at average concentration of 30.000 particles/cm^3 (10^5 µg/m^3). Particle size distribution has been determined: number size distribution is d_{50}= 0.5 µm and d_{90}=2.5 µm, mass size distribution is $d_{50=}$3.8 µm and d_{90}=7 µm.

Table 1. Prototype filters

	Efficiency/ Geometry	Material	Filtration velocity (m/s)
	G4/ pleated	Cotton+ polyester fibres	0.9
	F7 / 2 bags	Glass fibre	0.4
	F9 / 2 bags	Glass fibre	0.4

Changes in pressure drop and efficiency during clogging of the different filters are compared according to the mass of particles retained on filters. Comparisons allow evaluating the influence of filters geometry on the change in performances during time.

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