Numerical and Experimental study of pressure drop for transverse flow within corrugated filter pleat channels

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Abstract

Pleated media are typically used in all kinds of air filters (diesel, automotive, etc.). Pressure drop is one major factor used in the evaluation of filter performance. In recent times computational fluid dynamic (CFD) techniques are being used for designing filters. Current computational capabilities are not at a point where the entire pleated structure can be easily included in the CFD analysis. Darcy's porous zone approximation is instead used to represent the media. The resistance offered to the flow inside the zone has to be assigned correctly so that it would approximate flow through the actual media. To that end the flow through and between the pleats has to be understood, including the relative flow resistance in each of three directions – "through" the pleated media, parallel to the pleat within gaps (the direction reported herein), and perpendicular to the pleats.

Previous studies have focused on flow going through the pleats where the pressure drop was reported as a function of media permeability, pleat thickness, packing density, etc. Similar such correlations for flow parallel to the pleats within the pleat gaps are necessary for assigning correct viscous resistances in the CFD porous zone model. Adjacent pleats form long narrow channels and Poiseulle flow equations can be used to describe the flow assuming no wall suction or injection. However, with the addition of corrugations to the pleats the walls of the channel are not smooth and the Poiseulle pressure drop has to be modified to take the corrugations into account. The present study is focused on developing such correlation using both numerical methods (Fluent CFD) and experimental test validation.