S2.6.2 DESIGN AND EVALUATION OF A METALLIC GASOLINE PARTICULATE FILTER MADE OF SINTERED METAL FIBER FILTER MEDIA

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A novel metallic gasoline particulate filter (GPF), employing sintered metal fiber media as filtration material, is designed and evaluated. A design and optimization model is developed based on single fiber efficiency theory and Kuwabara flow model for fibrous filter media. A design concept is proposed by applying the two constraints, one for minimum PM removal efficiency and the other for maximum filter backpressure, while also considering the size limit of the filter unit and the availability of metallic fibers that tolerate gasoline engine exhaust temperatures. Prototypes based on the design optimization are manufactured and then evaluated by both vehicle chassis dynamometer and engine dynamometer testing. Integrated mass collection efficiency of greater than 78% is found for both FTP-75 and US06 drive cycle, with an average backpressure less than 1 kPa over US06 drive cycle, on a 2.0 liter GDI engine passenger car. PM removal efficiencies measured under engine dynamometer at constant exhaust temperature and flowrate agree well with model predictions. However, the media based model underestimates GPF backpressure by missing other contributors, including friction loss in air channels formed by filter media, as well as contraction and expansion loss at entrance and exit of both filter element and filter housing pipe junction. The pressure drop of the entire GPF unit was then further studied using a commercial CFD tool, showing better agreement with experimental observation.