NEW CORDIERITE DIESEL PARTICULATE FILTERS FOR CATALYZED AND NON-CATALYZED HEAVY-DUTY APPLICATIONS

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ABSTRACT

Ceramic wall-flow diesel particulate filters (DPF's) are presently being explored for the collection and combustion of carbonaceous soot in heavy-duty vehicle applications. To minimize reduction in vehicle power, it is important for the DPF to have a low pressure drop. The pressure drop of a DPF is known to increase with the accumulation of soot. Furthermore, depending upon the type of engine and the strategy employed to initiate regeneration of the filter, DPF's may be catalyzed to reduce emissions of NO_x, CO, and HC, as well as to lower the temperature required for regeneration. The presence of a catalyst within, or on top of, the filter wall can further contribute to an increase in pressure drop of the filter. To minimize the pressure drop for catalyzed and non-catalyzed filters, it is necessary to optimize the pore microstructure of the ceramic walls as well as the external dimensions and cell geometry of the filter.

Cordierite DPF's provide an economical approach to diesel emission control. However, further reduction in the pressure drop of catalyzed and non-catalyzed cordierite filters is desirable. In an effort to develop new cordierite filters that possess lower pressure drop while maintaining high filtration efficiency and strength, cordierite ceramics have been fabricated spanning an extended range in porosity, pore-size distribution, and pore connectivity. Pressure drops of the clean and soot-loaded filters before and after catalyst impregnation have been measured over a series of flow rates for a wide range of pore microstructures. Analysis of the results has provided explicit equations relating the pressure drop versus soot- loading behavior to the porosity and pore-size distribution of the ceramic wall, and has increased the fundamental understanding of the relationship between filter permeability and pore microstructure.

Optimum values for the percent porosity, median-pore diameter, and breadth of the pore- size distribution for minimizing pressure drop have been identified. These results have been applied to the development of several new, high-porosity, cordierite diesel particulate filters that possess a unique combination of high filtration efficiency, high strength, and very low clean and soot-loaded pressure drop in both the catalyzed and non-catalyzed states. By controlling the microstructure, the impact of the catalyst on pressure drop has been minimized. Soot-loaded pressure drops of these new filters in their catalyzed state are less than 50 percent of other catalyzed commercial filters with the same cell geometry.