Gasoline Engine Emission Characterization and Gasoline Particulate Filter Advanced Aging System

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Worldwide focus on the reduction of emissions from internal combustion engines has become a major driving factor in the development of new engine technologies. One such technology is direct fuel injection for downsized gasoline engines in light duty road vehicles; while direct injection offers significant fuel economy and CO/NO_X emission advantages, it also emits elevated levels of particulate matter (PM) in the form of soot, on par with small diesel engines. Near-future emissions regulations impose strict limits on PM emissions from gasoline engines, and one strategy for meeting these limits is the use of gasoline particulate filters (GPF). These filters are manufactured from a porous ceramic substrate called cordierite, which offers excellent capture efficiency for both incombustible ash – derived from consumption of lubricating oils – and PM in the form of soot. Soot is periodically purged from the filter through regeneration, an elevation of temperature of the filter which combusts all remaining soot in the filter. As the filters age, incombustible ash is accumulated, increasing backpressure and affecting system performance.

This project developed a novel accelerated aging system, consisting of a gasoline fueled combustion chamber with lubricant oil injection, thereby simulating the major sources of PM emissions from a combustion engine. This system allows rapid accumulation of incombustible ash in the GPF, to simulate a full useful life of 150,000 miles in a matter of a few weeks. The system was validated by comparison to previous results and engine out emissions obtained from a co-located 1.6L Ford direct injection engine. Multiple GPF were loaded to various ash levels, pressure drop recorded, then ash distribution and morphology were characterized using advanced imaging techniques, particularly Transmission Electron Microscopy (TEM) and 3-Dimensional Computed Tomography (CT) Scanning.

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