S2.6.4 CHARACTERIZATION AND CONTROL OF PARTICULATE MATTER FROM MODERN GDI ENGINES

John Storey*[1], Melanie Moses-Debusk[2], Samuel Lewis[2], Eric Nafziger[2]

[1]Oak Ridge National Laboratory Energy and Transportation Sciences Division, [2]Oak Ridge National Laboratory

New regulations requiring increases in vehicle fuel economy are challenging automotive manufacturers to identify fuel-efficient engines for future vehicles. Gasoline direct injection (GDI) engines offer significant increases in fuel efficiency over the more common port fuel-injected (PFI) engines. However, particulate matter (PM) emissions from GDI engines may make it challenging to meet future Environmental Protection Agency regulations. As such, the control of GDI PM with wall-flow filters, referred to as gasoline particulate filter (GPF) technology, is of interest. Since GDI PM chemistry and morphology differ from diesel PM (where more filtration experience exists), the functionality of GPFs needs to be studied to determine the operating conditions suitable for efficient PM removal. In addition, GDI engine exhaust temperatures are generally higher than diesel engines which results in more continuous regeneration of the GPF and less presence of the soot "cake" layer common to diesel particulate filters. Since the soot layer improves filtration efficiency, this distinction is important to consider.

This paper summarizes research at the Oak Ridge National Laboratory on the characterization and control of PM from both stoichiometric and lean-burn GDI engines and vehicles operating on gasoline and gasoline-alcohol blended fuels. Engines and vehicles were operated under steady-state and transient operation, including vehicle start-stop modes where the engine shuts off when the vehicle is at rest. PM mass, transient particle number concentration and size distribution, soot concentration, and PM chemistry were evaluated. Organic and elemental carbon (OC/EC) analysis revealed high proportions of EC in general, although fuel composition could impact that ratio. Fuel composition also altered PM chemistry and soot oxidation behavior as well. Transients, particularly under cold start conditions, were observed to produce the highest levels of PM. PM emissions were not necessarily higher with Start-Stop vehicle operation. For GPF tests, High (>95%) PM filtration efficiencies were observed over a wide range of conditions; however, some PM was observed to slip through the GPF at high speed and load conditions.