

Characterizing Ash and Substrate Properties in Sintered Metal Fiber Diesel Particulate Filters using an Advanced Diagnostic Approach

LT Paul Folino, USCG

Dr. Victor Wong

Thesis Supervisor

In order to comply with strict air emissions regulations, applicable diesel engines are required to have an installed after-treatment device. A diesel particulate filter (DPF) is one of these after-treatment devices, and it is used to capture hazardous particulate matter (PM) from the engine exhaust stream. Over the lifetime of the DPF, incombustible materials such as lubricant-derived ash are deposited within the DPF. The presence of ash restricts the exhaust flow and thus causes an increase in the pressure drop across the filter. This increase in pressure drop due to ash accumulation has an adverse effect on engine performance, primarily a reduction in fuel economy.

The global effects of ash on engine performance are well researched and understood, however, the fundamental mechanisms of ash accumulation in the DPF require further understanding. Experimental data mainly addresses how ash reduces filter porosity and influences pressure drop across the filter, but an investigation of these properties reveals how other key sub-parameters, such as ash particle size and distribution and filter oxidation level, significantly contribute to an increase in pressure drop as well.

The focus of this work is to understand the behavior of ash particles in a sintered metal fiber (SMF) filter substrate and recognize the resultant effect on DPF pressure drop using an advanced diagnostic approach. Much of the work relies on the use of sophisticated imaging and software tools as well as basic computational fluid dynamics (CFD) simulations to quantify properties such as particle size, particle distribution, filter porosity, and pressure drop among others. Additionally, this research introduces and demonstrates the capabilities of these cutting-edge tools and how they can best be utilized to provide filter performance data to qualify existing and future experimental data for SMF or cordierite filters. An analysis of the data reveals a statistically significant dependence between pressure drop and the aforementioned sub-parameters.

Master of Science in Naval Architecture & Marine Engineering

Master of Science in Mechanical Engineering