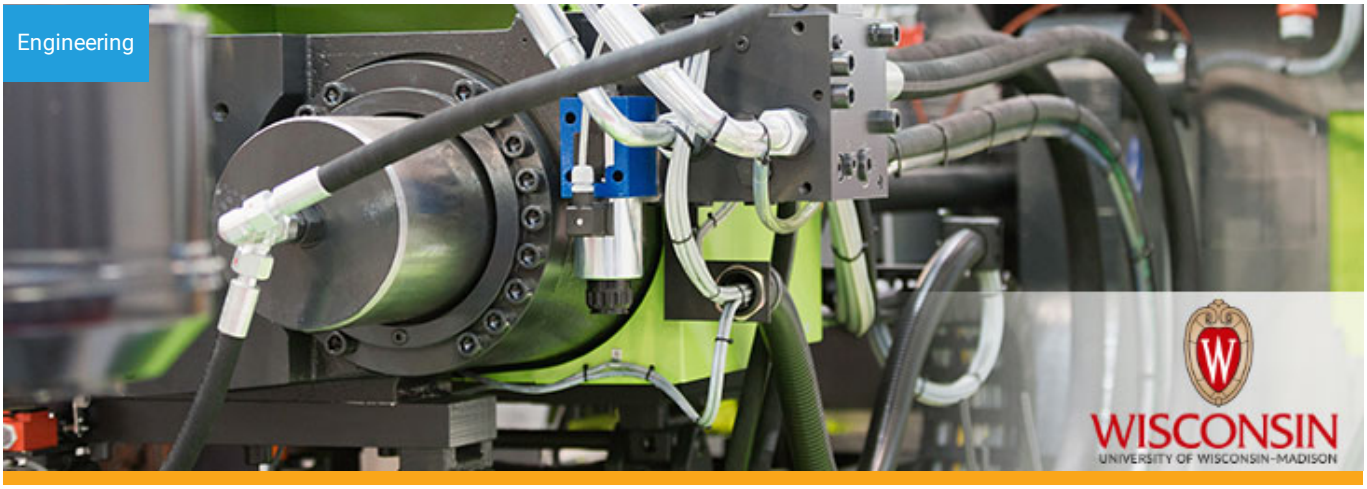
Engineering



Internal Combustion Engine Exhaust Filtration Analyzer

View U.S. Patent No. 8,074,505 in PDF format.

WARF: P08173US

Inventors: David Foster, Ekathai Wirojsakunchai, Christopher Kolodziej, Renato Yapaulo

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a system to analyze internal combustion engine exhaust filtration devices.

Overview

Internal combustion engines are a major contributor to atmospheric pollution, emitting carbon oxides, nitrogen oxides and sulfur oxides. Federally mandated emission regulations effective in 2010 are forcing diesel engine manufacturers to implement exhaust treatment systems to reduce emissions. Industry observers expect that future regulations will require nearly all fixed and mobile atmospheric polluters to meet strict emissions standards, requiring incorporation of exhaust filtration devices.

Currently, diesel particulate filters (DPFs) are the most effective type of exhaust after-treatment for diesel engines, removing about 85 percent of particulate matter. The most common DPFs must be regularly cleaned and regenerated to ensure optimal performance. Characterizing the performance of DPFs is difficult because of the number of kinetic parameters and reaction phenomena that affect particulate matter measurements. Miniature DPFs regularly are used to conduct tests on DPF systems, but it is difficult to manipulate system parameters to model realistic exhaust conditions.

The Invention

UW-Madison researchers have developed an improved method and system for analyzing the performance of filtering materials used in DPFs and other exhaust filtration devices. The new method is able to replicate actual in-use processes that occur during filling and regeneration of filtration devices. The ability to accurately replicate realistic conditions and manipulate key system parameters sets the new method apart from previous techniques and allows for more accurate and complete analyses of exhaust filtration materials.

Control of the various operational parameters is provided by variable exhaust flow restriction with an actuating valve and orifice in the exhaust system. In a diesel engine, the exhaust back pressure can be modulated to control the flow characteristics of the exhaust with an actuating value through feedback from a differential pressure sensor placed across the filtering material. A mass flow controlled orifice may be incorporated downstream of the exhaust analyzer to control the filtration velocity independent of engine operating conditions. The orifice also allows control of total downstream flow rate while diluting the sampled exhaust with a constant flow of air and provides a constant volume ratio of exhaust and air. Both improve the evaluation of filter performance by reducing the number of dynamically changing parameters. The exhaust also may be cooled in stages to control temperature-related characteristics of the exhaust, increasing the accuracy of results.

The implementation of exhaust filtration devices will continue to grow with increasing government regulation of emissions from mobile and stationary internal combustion engines. As these regulations become more stringent and encompassing, exhaust filtration analysis will be an increasingly important tool in the filtration material development and certification of DPFs and other exhaust filtration devices.

Applications

- Research and development of diesel engines
- Analysis of current exhaust filtration materials and devices
- Research and development of filtration devices for all internal combustion engines

Key Benefits

- Controls key system parameters to mimic realistic operating conditions
- Allows study of filtration dependence on diffusion, interception and impaction
- Discerns the nature of the particulate loading within the filtration media
- Applicable in all combustion exhaust treatment processes

Stage of Development

The diesel exhaust filtration analyzer has been successfully tested, showing control of all filtration parameters including flow rate, temperature and particulate matter characteristics. The filter material samples have been analyzed for evaluation of particulate loading distributions within the media.

Additional Information

For More Information About the Inventors

- David Foster

Publications

- Tao F., Foster D. E. and Reitz R. D. 2007. Characterization of Soot Particle Distribution in Conventional, Non-Premixed DI Diesel flame Using a Multi-Step Phenomenological Soot Model. Proc. of the Comb. Inst. 31, 2991-2998.
- Yapaulo R.A., Wirojsakunchai E., Orita T., Foster D.E., Akard M., Walker L.R. and Lance M.J. 2009. Impact of Filtration Velocities and Particulate Matter Characteristics on Diesel Particulate Filter Wall Loading. Inter. Jour. Eng. Res. 10, 287-304.

Tech Fields

- Analytical Instrumentation, Methods & Materials : General analytical instrumentation
- Engineering : Engine technologies

For current licensing status, please contact Emily Bauer at emily@warf.org or 608-960-9842