Filter Manufacturers Council

Filter Knowledge, Unfiltered

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Crankcase Ventilation Filtration Systems for Diesel Engines

Overview

During normal diesel engine combustion, a significant volume of combustion gas and particles escape past the piston rings and enter the crankcase. This internal “blow-by” gas must be vented through a tube into the atmosphere to avoid pressurizing and damaging the oil pan. After mixing with oil mist in the crankcase, the gases and oil vapor either condense and drip out of the vent tube onto the ground, or enter into the atmosphere as pollutants.

Now accepted worldwide, environmental protocols recommend or require crankcase emissions to be recycled or trapped in a closed system on the engine. Various technologies and devices are available now to remove the bulk of oil vapors and particles from the crankcase emission stream.

EPA Regulates Crankcase Emissions

Typical crankcase emissions regulated by the EPA are diesel particulate matter, some nitrogen oxides, hydrocarbons, and carbon monoxide. Fine oil droplets, soot, and vapors generated in the diesel engine crankcase range in size from 0.1 to 10 micrometers or microns. The concentration and distribution of these particles varies greatly with engine rpm and load. Effective for 2007 model year highway trucks, crankcase emissions will be measured and included with exhaust emission results. Diesel engine manufacturers will be expected to control crankcase emissions by re-routing them back to the intake for re-combustion, or routing them to the exhaust stream, upstream of the exhaust emission control devices. Since crankcase emissions contain engine damaging contaminants, these emissions must be cleaned and filtered before they can be recycled back through the engine.

Crankcase Emission Filtration Technologies

Crankcase ventilation or filtration systems must work across a wide range of particle sizes, flow velocities, pressures, and temperatures. No single technology is available to cover all diesel engine applications. Diesel engine manufacturers must tailor the crankcase filter system to fit their unique applications.

Current “open to atmosphere” crankcase emission filtration systems are designed to recover nuisance oil vapors before they escape to the ground or coat engine components. On and off highway vehicles may have one or more stages of baffles and traps to minimize oil dripping. The baffles and traps may use metal mesh and depth style media to condense and recover fine oil mists. Oil vapor management is also important in marine engine rooms or stationary power generation applications in hospitals and other enclosed environments.

Open crankcase ventilation or filtration systems are generally simple and relatively inexpensive when compared to the closed systems. Open systems rarely need service and go a long way to reduce and recover oil vapors. However, open systems have low efficiencies and do nothing to reduce polluting gases.

Closed crankcase ventilation or filtration systems must efficiently remove and filter oil and soot to protect turbochargers and aftercoolers, or exhaust system components, depending on the diesel engine manufacturer’s strategy to close the crankcase system. In the case of systems designed to return gases to the air intake, the outlet of the crankcase filter is routed ahead of the turbocharger and after the air filter. This system requires a pressure balancing mechanism to avoid damaging the oil pan seals. With a new air filter in place and under idle conditions, it is possible that the oil pan pressure may exceed safe limits across a crankcase filter. In that case, a valve opens to temporarily bypass the crankcase filter and relieve oil pan over pressure. Under heavy load and/or a partially plugged air filter, there may be a net vacuum on the oil pan. In this case a valve in the crankcase filter limits vacuum in the crankcase until pressure builds again. Regardless of the technology, a closed system crankcase filter maintains normal vapor pressures in the engine.

Currently, there are two available high efficiency technologies to filter crankcase ventilation emissions in a closed system. One is through centrifugal action, which coalesces oil and soot out of the vapor stream and returns it to the oil pan. Centrifugal filters can be passive or mechanically driven. Crankcase filters using pleated or depth style media, have the advantage of higher efficiency across a wider engine load and rpm operating range. They also remove and hold contaminants and soot. Other types of technologies may be developed to meet any future needs and emission regulations.

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