

CONTACT: Steve Gaut – 248-354-7826

### **Federal-Mogul's Breakthrough Diesel Piston Design Removes Barrier to Downsized Engines with Higher Output**

*DuraBowl® substantially improves piston durability in severe conditions*

Southfield, Michigan, November 3, 2009 ... To reduce CO<sub>2</sub> emissions and improve fuel economy, vehicle manufacturers are demanding higher and higher power output from smaller and smaller engines. Federal-Mogul Corporation (NASDAQ:FDML) has developed an innovative aluminum piston design that can reliably withstand the mechanical and thermal loads produced by heavily boosted engines, thereby enhancing diesel engine performance. Called DuraBowl®, Federal-Mogul's design strengthens the crown of a piston by locally re-melting the alloy around the bowl, significantly improving the fatigue strength of the aluminum where it is most needed. The result is an extension of engine life to between four and seven times that achieved with a conventional cast piston.

During the last decade, typical performance outputs for automotive diesel engines rose from 50kW/litre (67bhp/litre) to around 70kW/litre (94bhp/litre). According to Rainer Jueckstock, Federal-Mogul senior vice president of Powertrain Energy, with increasingly pressing legislative targets for CO<sub>2</sub> reduction in most major global markets, the trend is likely to accelerate. "Rising specific outputs place higher mechanical and thermal loads on many of the components where Federal-Mogul has considerable expertise," he said. "The DuraBowl piston process is an example of how we are succeeding in delivering specialized process technologies that help our customers successfully address these challenges across a range of growing market sectors."

(more)

The combustion in a diesel engine takes place in a hollow bowl in the top of the piston, where temperatures can reach over 400 degrees Celsius (750 degrees Fahrenheit) and pressures over 200 Bar (200 x atmospheric pressure). Under these increasingly difficult combustion conditions, the rim of the piston bowl has an increased failure factor. Following extensive analysis, Federal-Mogul's engineers have identified that both thermal and mechanical failures of the piston bowl can be traced to the presence of free primary silicon particles distributed throughout the aluminium matrix. Aluminum expands eight times as much as silicon, therefore stresses are set up within the piston every time the temperature fluctuates. Furthermore, repeated mechanical loads, each time the cylinder fires, could result in fatigue failure from the corners of the silicon particles. Silicon is a necessary constituent of the aluminum alloy, offering favorable properties such as low expansion and good castability, so it cannot be eliminated.

The only potential solutions to this problem, until now, have been fiber-reinforced pistons. "Fiber-reinforced pistons increase manufacturing complexity as the molten alloy has to infiltrate the fibers during casting," said Frank Doernenburg, Federal-Mogul director of technology, pistons and pins. "Furthermore, there is not yet a reliable, non-destructive way to test the integrity of the finished part whereas, with our DuraBowl process, we can do an Eddy Current test to ensure the quality."

Federal-Mogul's solution is to pre-machine the cast piston and then re-melt the alloy around the rim of the bowl. "The strength and efficiency of our solution is that the process is physically simple," said Doernenburg. "The sophistication is in the control of key parameters, which ensure consistent quality. The result is a technologically advanced, high-performing and very cost-competitive product when compared to both fiber-reinforced and steel pistons."

The re-melted alloy cools a thousand times faster than it did when originally cast, which leads to much smaller silicon particles; only one tenth of the previous size. Metallurgists refer to this as refinement of the microstructure; a technique known to increase the strength and durability of metal alloys.

The technological and cost benefits have been validated during extensive engine testing, both by Federal-Mogul and its customers. Doernenburg concluded, “The re-melting process certainly increases piston life and performance substantially, while at the same time, serving as a contributor to improve fuel efficiency and reduce CO<sub>2</sub>. A conservative estimate would be a fourfold improvement in the life of any cast piston which suffers from bowl rim failures.” The first application of the DuraBowl process is on a high-performance diesel engine recently launched for a leading global vehicle manufacturer.

### **The metallurgy of DuraBowl®**

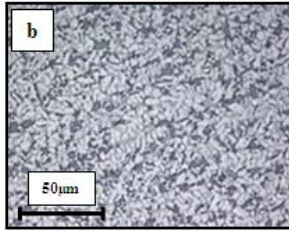
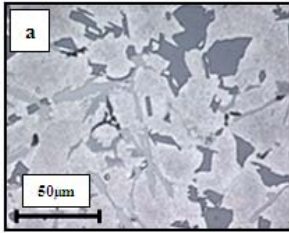
Federal-Mogul’s unique re-melting process for the aluminum-silicon alloy, combined with a rapid cooling process, significantly changes the alloy’s microstructure by reducing the size of hardening phases such as silicon particles and intermetallics. The result is a piston bowl rim whose first few millimeters provide significantly improved aluminum strength, further enabling engine manufacturer’s efforts to downsize or turbo-boost engines for greater specific output.

### **About Federal-Mogul**

Federal-Mogul Corporation is an innovative and diversified \$6.9 billion global supplier of quality products, trusted brands and creative solutions to manufacturers of automotive, light commercial, heavy-duty and off-highway vehicles, as well as to the power generation, aerospace, marine, rail and industrial sectors. It is recognised as a premier global innovator in the areas of powertrain, sealing, safety and protection and a leading source of advanced technologies that help increase vehicle performance, improve fuel efficiency and reduce engine emissions for a cleaner world. Federal-Mogul employs nearly 39,000 people located in 36 countries. More information can be found at [www.federalmogul.com](http://www.federalmogul.com)

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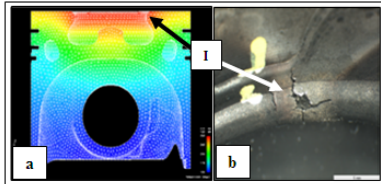
## Images



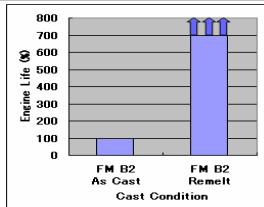
Microstructure of a typical piston alloy (a), as cast, showing a coarse structure and (b), re-melted, showing a finer structure. The dark grey areas are silicon particles; the light grey areas aluminium. Illustrations are at the same scale, showing that the grain size of the re-melted part is approximately one tenth of the as-cast size. The smaller particle size gives much improved resistance to cracking under both mechanical and thermal loads.



Federal-Mogul's new DuraBowl technology optimises the grain size around the piston rim.



Typical failure due to thermal stresses, showing (a) the temperature distribution in a hot piston, (b) typical location of crack origin at point I on the edge of the bowl, in line with the thrust and non-thrust faces of the piston.



DuraBowl pistons have lasted up to seven times the life of standard pistons during validation tests carried out on actual engines.