DIESEL OXIDATION CATALYSTS FOR COMMERCIAL VEHICLE ENGINES: STRATEGIES ON THEIR APPLICATION FOR CONTROLLING PARTICULATE EMISSIONS

Dan Draghia
Registrul Auto Roman Galati

ABSTRACT

A variety of diesel oxidation catalysts were tested on a Mercedes – Benz direct injection, turbocharged-intercooled commercial vehicle engine in order to identify the strategy for the selection of the optimal engine/catalyst combination for different engine applications and markets. The influence of the emissions certification test cycles on the catalyst choice was also investigated.

The light-off temperatures for carbon monoxide (CO) and hydrocarbons (HC) were significantly lower for catalysts with a high platinum loading, as compared to catalysts with palladium and low platinum loadings. The particulate (PM) emission at light load operation was reduced by 75% to 85% with all catalysts due the high conversion rate of the PM soluble organic fraction (SOF). The PM efficiency still increased by 5% at medium load operation, and then started to decrease at a temperature around 550 K due to increased sulfate formation. The sulfate formation could be minimized by a higher space velocity, an optimized washcoat, and a lower platinum or palladium loading, respectively.

On the US transient cycle, PM was reduced by 20% to 35% with all catalysts tested. Among the two catalysts with 35% efficiency, the low Pt catalysts D produced less sulfate at high temperatures was selected as first choice. Deterioration of catalyst D over 2200 h was 8% for PM, 13% for CO and 21% for HC.

On the European 13-mode cycle, PM was reduced by 9% only with optimized low Pt catalyst G, but increased dramatically with all other catalysts (including those selected for US) due to a considerable sulfate formation. Since the SOF fraction is lower on this cycle compared to the US transient cycle, the PM removal potential of an oxidation catalyst is generally lower under European certification conditions, and different catalyst technologies will have to be selected for US and European applications. Only if rape seed methyl ester (RSME) is used as an alternative to diesel fuel, an oxidation catalyst is an effective means not only for decreasing HC and CO, but also PM.

REFERENCES

[1] J. Widdershoven, F. Pischinger, G. Lepperhoff et al., Possibilities of Particle Reduction for Diesel Engines, SAE 860013, 1986
[2] R.R. Richards and J.E. Sibley, Diesel Engine Emissions Control for the 1990’s SAE 880346, 1988
[3] A.P. Gill Design Choices for 1990’s Low Emission Diesel Engines, SAE 880350, 1988
[4] P. Zelenka, K. Ostgathe and E. Lox, Reduction of Diesel Exhaust Emissions by Using Oxidation Catalysts, SAE 9021111, 1990
[5] Code of Federal Regulations, Title 40, Part 86, Subpart N, Emission Regulations for New Gasoline and Diesel-Fueled Heavy Duty Engines
[6] S. Reichel, F. Pischinger and G. Lepperhoff, Influence on Particles in Diluted Diesel Engine Exhaust Gas, SAE 831333, 1983
[7] J.C. Wall, S.A. Shimpi and M.L. Yu, Fuel Sulfur Reduction for Control of Diesel Particulate Emissions, SAE 872139, 1987
[8] R.A. Baranescu, Influence of Fuel Sulfur on Diesel Particulate Emissions, SAE 881174, 1988

[9] G.M. Cornetti, K. Klein, G.J. Frankle and H.J. Stein, U.S. Transient Cycle Versus ECE R 49 13-Mode Cycle, SAE 880715, 1988
[10] H.O. Hardenberg, H.L. Daudel and H.J. Erdmannsdorfer, Experiences in the Development of Ceramic Fiber Coil Particulates Traps, SAE 870015, 1987
[11] M.G. Henk, W.B. Williamson and R.G. Silver, Diesel Catalysts for Low Particulate and Low Sulfate Emissions, SAE 920368, 1992
[12} H.G. Stein, G. Huthwohl and G. Lepperhoff, Performance of Oxidation Catalysts for Heavy-Duty Diesel Engines, Third International Congress on Catalysts and Automotive Pollution Control (CAPoC 3), 20-24 April 1994, Brussels, Belgium
[13] M.K. Khair and B.B. Bykowski, Design and Development of Catalytic Converters for Diesels, SAE 921677, 1992
[14] D.J. Ball and R.G. Stack, Catalysts Considerations for Diesel Engines, SAE 902110, 1990
[15] W. Heinrich and A. Schafer, ATZ 92 (1990) 168-173.