STATE-OF-THE-ART AND FUTURE DEVELOPMENTS IN NATURAL GAS ENGINE TECHNOLOGIES

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ABSTRACT

Current, state-of-the-art natural gas engines provide the lowest emissions commercial technology for use in medium- to heavy-duty vehicles. NO_x emission levels are 25-50 percent lower than October 2002 diesel engines, and particulate matter (PM) levels are 90 percent lower than non-filter equipped engines. Yet, in common with diesel engines, natural gas engines are challenged to become even cleaner and more efficient to meet environmental and end-user demands. Cummins Westport is developing two streams of technologies to achieve these goals for medium-heavy and heavy-heavy duty applications.

For medium-heavy duty applications, lowest possible emissions are sought on SI engines without significant increase in complexity and with improvements in efficiency and BMEP. The selected path builds on the capabilities of the Cummins Westport, Inc., Plus technology and recent diesel engine advances in NO_x controls, providing the potential to reduce emissions to 2010 values in an accelerated manner and without the use of selective catalytic reduction (SCR) or LNA technology.

For heavy-heavy duty applications where high torque and fuel economy are of prime concern, the Westport-Cycle™ technology is in field trial. This technology incorporates high-pressure direct injection (HPDI) of natural gas with a diesel pilot ignition source. Both fuels are delivered through a single, dual common rail injector. The operating cycle is entirely unthrottled and maintains the high compression ratio of a diesel engine. As a result of burning 95 percent natural gas rather than diesel fuel, NO_x emissions are halved, and PM is reduced by around 70 percent. High levels of exhaust gas recirculation (EGR) can be applied while maintaining high combustion efficiency, resulting in extremely low NO_x potential.

Some recent studies have indicated that diesels equipped with diesel particulate filters (DPF) emit fewer nanoparticles than some natural vehicles. It must be understood that the ultra fine particles emitted from SI natural gas engines are generally accepted to consist predominantly of VOC's and that lubricating oil is a major contributor. Fitting an oxidation catalyst to the natural gas engine leads to a reduction in nanoparticle emissions in comparison to engines without aftertreatment.

In 2001, the Cummins Westport Plus technology was introduced with the C Gas Plus engine, a popular choice for transit bus applications. This incorporates drive by wire; fully integrated, closed loop electronic controls; and a standard oxidation catalyst for all applications. The B Gas Plus and the B Propane Plus engines, with application in shuttle and school buses, were launched in 2002 and 2003. The gas-specific oxidation catalyst operates in concert with an optimized ring-pack and liner combination to reduce total particulate mass below 0.01g/bhp-hr, combat ultra fine particles, and control VOC emissions.