DEVELOPMENT AND DEMONSTRATION OF FISCHER-TROPSCH FUELED HEAVY-DUTY VEHICLES WITH CONTROL TECHNOLOGY FOR REDUCED DIESEL EXHAUST EMISSIONS

Brad Adelman and Mike May

Ricardo

Teresa Alleman

National Renewable Energy Laboratory

Adewale Oshinuga

South Coast Air Quality Management District

Bernard Treanton

California Energy Commission

Greg Barton

Automotive Testing Laboratory

Ralph Cherrillo and Ian Virrels

Shell Global Solutions

ABSTRACT

The objectives of this study are to modify two 2002 Model Year Cummins ISM engines (equipped with exhaust gas recirculation [EGR]) to achieve 1.2 g/hp-h NO_x emissions and 0.01 g/hp-h particulate matter (PM) over the heavy-duty Federal Test Procedure (FTP) cycle using Fischer-Tropsch (F-T) fuel, optimized combustion, lean NO_x catalyst (LNC) with secondary injection, and a diesel particulate filter (DPF). After their performance is proven in a test cell, the plan is to install the modified engines and aftertreatment systems in two vehicles and operate the vehicles in a commercial application. The program is sponsored by the South Coast Air Quality Management District, the California Energy Commission, the U.S. Department of Ener-gy, and the National Renewable Energy Laboratory

This presentation covers the first phase of the work — the optimization of the en-gine and aftertreatment systems to demon-strate the targets in an emissions test cell.

The effect of F-T fuel on the base engine was first evaluated over the heavy-duty diesel FTP cycle. In comparison to a low aromatic California Air Resources Board ultra-low sulfur diesel fuel, a 4.5-percent decrease in NO_x and a 17.6-percent decrease in PM were measured.

To achieve a major reduction in engine out NO_x emissions, the chosen strategy was to increase the EGR rate and employ an LNC. To tolerate higher EGR rates, the combustion bowl was modified to increase the bowl volume (decreased compression ratio is possible due to the superior ignition qualities of F-T fuel) and air motion. Increased EGR rate and combustion modi-fications lead to a further 25-percent de-crease in NO_x but a 30-percent increase in PM.

An exhaust aftertreatment system con-sisting of an LNC and catalyzed DPF was then installed. The efficiency of catalyzed aftertreatment is improved with virtually sulfur-free F-T fuel. Secondary F-T fuel was added to the exhaust to facilitate the LNC performance. The exhaust aftertreatment led to a further 19-percent NO_x reduction and 95-percent PM removal Composite emis-sions of 1.168 g/hp-h NO_x and 0.005 g/hp-h PM were achieved over the heavy-duty FTP cycle.