ENGINE EVALUATION OF FISCHER-TROPSCH DESEL FUEL, PHASE I

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INTRODUCTION

Engine manufacturers and refiners have long recognized the importance of fuel quality on diesel engine performance and emissions. The Coordinating Research Council examined this issue in some detail in a series of projects designed to quantitatively document the relationships between engine performance and emissions and fuel properties and composition[1-5]. This work was performed in what has been called a "prototype" Series 60 Detroit Diesel engine. The results of this work have indicated that cetane number and aromatic content are the primary fuel properties controlling the emissions. Additional work performed at Southwest Research Institute (SwRI) has also indicated that the types of aromatic materials are more important that simply the total mass of aromatic material in the fuel[6]. This same work demonstrated that significant emissions benefits were associated with the use of diesel fuels derived from Fischer-Tropsch processing of coal.

The test protocol used in the Prototype Series 60 testing involved the use of the Federal Heavy Duty Transient Test Procedure (FTP), as specified in the Federal Register. More recently, this same engine and the FTP have been adopted as the basis for the CARB Protocol for certifying reformulated diesel fuels in California.

OBJECTIVE

The main objective of this study was to evaluate Fischer-Tropsch (FT) diesel fuel as a low emissions diesel fuel.

EXPERIMENTAL APPROACH

The work reported in this presentation involves the comparative testing of three Fischer-Tropsch diesel fuels and two different conventional petroleum derived fuels; one representing a national average low sulfur diesel fuel, and one representing a typical low aromatic content California reformulated diesel fuel. The tests were performed in the same Series 60 engine used in the CARB Protocol, following the same basic procedures as used in the protocol.

As indicated, the group of fuels included a low-sulfur emissions 2D reference fuel, identified as Fuel 2D, three FT candidate fuels identified as Fuels B1, B1, and B3, and a "pseudo" California reference fuel, designated Fuel PCR. Transient cycle emissions of HC, CO, NO_X, total particulate (PM), sulfate, soluble organic fraction (SOF) of PM, and volatile organic fraction (VOF) of PM were obtained over repeat hot-start tests.

TEST RESULTS

Figure 1 illustrates that average hot-start transient emission levels of HC, CO, NO_X, PM, and SOF obtained with Fuels B1, B2, and B3, were all lower than those using Fuels PCR and 2D. Compared to Fuel 2D, the FT fuels showing the largest decrease in emissions were Fuel B1 for HC (46%), Fuel B2 for CO (47%), both Fuels B1 and B3 for NO_X (9%), Fuel B2 for PM (32%), and both Fuels B1 and B3 for SOF (47%).

SUMMARY

The main objective of this study was to evaluate the effects Fischer-Tropsch (FT) derived diesel fuels have on emissions from a heavy-duty truck engine. A screening test procedure was used based on transient emissions measurement procedures developed by the EPA for emissions regulatory purposes.

Average emissions of HC, CO, NO_X, PM, and SOF obtained with Fuels B1, B2, B3, and PCR were all less than with reference fuel, Fuel 2D. Furthermore, all these emissions were lower with FT fuels than on Fuel PCR. Fuel B1 had lowest HC, and Fuel B2 had lowest CO. Both Fuels B1 and B3 had low NO_X, but Fuel B2 had lowest PM.

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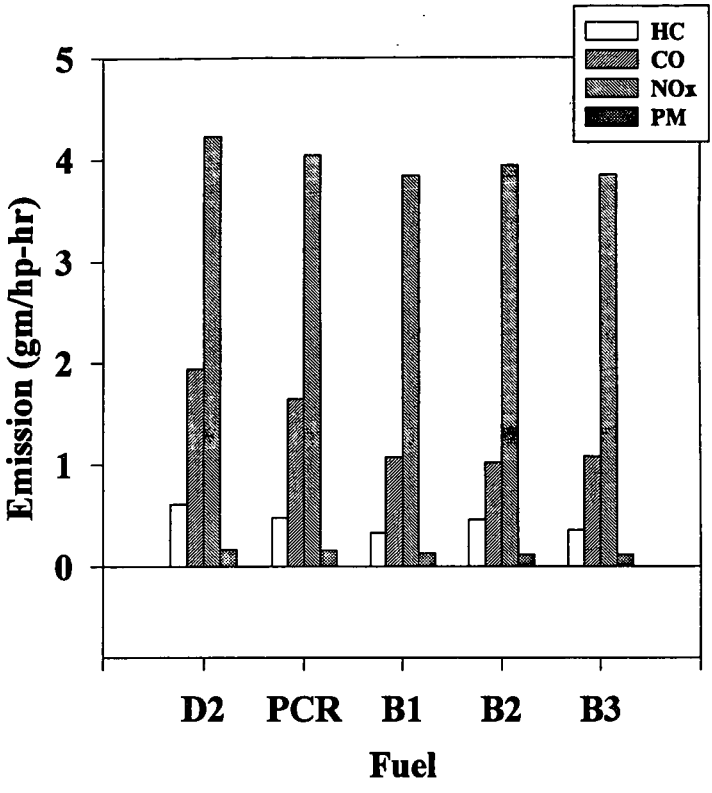

FIGURE 1. HOT-START TRANSIENT EMISSION LEVELS