Fuel borne catalysts and diesel aerosols emissions

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INTRODUCTION

The results of long-term evaluation tests and field and laboratory emission tests showed that the Mann-Hummel SMF-AR® system (currently marketed by HJS) is potentially a viable control technology that can be used to substantially reduce the exposure of underground miners to aerosols emitted by light-duty underground mining diesel-powered vehicles.

The operation of the SMF-AR® system requires the use of fuel additives containing iron-based fuel borne catalysts (FBCs).

Potential emissions of nano-sized metallic aerosols with high surface reactivity and toxicity and their potentially adverse effects in underground environments is of concern.

The NIOSH and Vale conducted a laboratory study to characterize the effects of selected fuel additives on the emission of aerosols and criteria gases emitted by a diesel engine equipped with the SMF-AR® system.

METHODS

The testing took place at the Diesel Laboratory at NIOSH OMSHR, Pittsburgh, PA.

The system was evaluated using auzu C240 engine coupled to eddy-current dynamometer. The engine was operated at four steady-state (R50, R100, IS, and I100) and one transient cycle (Inco LHD cycle).

The aerosol sampling and measurements were conducted in the exhaust diluted approximately 30 times using partial dilution system (Dekati FPS 4000).

RESULTS

For all studied cases, the FMPS results showed that the system filtered more than 99% of aerosols by number. With the exception of a couple test conditions, the evaluated additives slightly increased EOut total number concentrations. The fuels with additives consistently produced higher FOut concentrations of aerosols.

OBJECTIVES

The tests showed that the evaluated system was very effective in reducing EC, TC, and total number concentrations of aerosols.

The fuels with additives consistently produced higher FOut number concentrations of aerosols.

The effects of the additives on TC and EC concentrations were found to be function of engine operating conditions. In the cases of R50, IS, and I100, and TR tests, the EOut TC and EC concentrations were substantially lower when fuels treated with ULSD+DT8i and ULSD+DT9 were used in place of neat ULSD. In the cases of R100, the EOut TC and EC concentrations were substantially lower when ULSD+DT8i was used, but not when ULSD+DT9 was used in place of neat ULSD.

For the majority of the test conditions, the NO2 concentrations were lower downstream than upstream of the system.

CONCLUSIONS

• The tests showed that the evaluated system was very effective in reducing EC, TC, and total number concentrations of aerosols.
• With the exception of a couple test conditions, the evaluated additives slightly increased EOut total number concentrations.
• The fuels with additives consistently produced slightly higher FOut number concentrations of aerosols.
• In some cases, substantial fractions of FOut aerosols were found in pronounced nucleation modes.
• For all test conditions, Fe introduced with the additives substantially increased the Fe concentration in the EOut aerosol samples.
• However, the ULSD+DT8i and ULSD+DT9 FOut Fe concentrations were much lower than ULSD EOut concentrations.

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