Diesel Emissions Evaluation Program
Project Summary

Evaluation Of Biodiesel Fuel And Oxidation Catalyst In An Underground Metal Mine

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Complete Report

Executive Summary

The University of Minnesota (UMN), Inco, CANMET, Michigan Technological University (MTU), ORTECH, and the National Institute for Occupational Safety and Health (NIOSH) evaluated the impact of blended biodiesel fuel and modern diesel oxidation catalyst (DOC) on air quality and diesel emissions. The study was conducted at Inco's Creighton Mine in Sudbury, Ontario in October of 1997. Other organizations participating in the study included: the Manufacturers of Emission Controls Association, the Ontario Soybean Growers' Marketing Board, and the Deutz Engine Company.

The study characterized the concentration of diesel particulate matter (DPM) and exhaust gas emissions in a non-producing test section. During the first week of the evaluation a diesel-powered scoop was operated on low sulfur, number 2 diesel fuel (D2). During the second week the scoop was operated on a 58 % (by mass) blend of soy methyl ester (SME) biodiesel fuel and a low sulfur D2. During both weeks the scoop was equipped with a pair of identical, advanced design diesel oxidation catalysts (DOC). The objective of the evaluation was to determine changes in exhaust emissions and to estimate operating costs of a test vehicle fueled with blended biodiesel.

The results of this study are detailed in three reports. The chemical and biological analyses of particulate matter samples are summarized in the MTU report. Analyses of samples collected with a prototype denuder-difference sampling system for specific polycyclic aromatic hydrocarbons are summarized in the ORTECH report. This report summarizes the body of data collected to determine the difference in gaseous and particulate matter concentrations attributable to the use of a blended biodiesel fuel and catalyst.

Day-to-day variation in emissions was determined using the Emissions Assisted Maintenance Procedure (EAMP). This procedure requires that the test vehicle be operated for a short time under torque stall conditions while undiluted exhaust gas concentrations are measured at the tailpipe at points above and below the DOCs. Data obtained under these conditions are not representative of full-shift time-weighted average emissions, but do indicate the general condition of the engine and DOCs. No major changes in engine emissions were observed and the DOCs performed as anticipated. Carbon monoxide was effectively removed (98 ± 10 %, D2 fuel and 99 ± 11 % blended fuel) by the DOCs, but there was an increase in NO2 concentrations (185 % ± 78 % D2 fuel, 233 ± 59 % blended fuel). At this engine condition blended fuel increased NO2 concentrations downstream of the DOCs by 43 ± 28 %.

Air samples collected in the test section demonstrated that the combination of the blended biodiesel fuel and DOCs used in this study decreased total carbon emissions by about 21.4 ± 0.98 %. Elemental carbon was reduced by 28.6 ± 0.87 % and organic carbon was reduced 6.0 ± 3.32 % although the OC reduction was not statistically significant. This is lower than the initial expectation of 30 % - 50 % reduction. There was a slight, but statistically insignificant, increase in NO2 concentrations measured at the downwind location and a corresponding decrease in NO emissions, which was also statistically insignificant. SO2 levels were low during both weeks of testing. Reductions in mutagenicity and PAH concentrations are detailed in the MTU report.

Blended biodiesel fuel used in conjunction with a modern DOC offer a passive control option to reduce DPM in an underground mine. The primary limitation to the use of biodiesel fuel is cost. Typical biodiesel fuel ranges in price from $3.00 - $3.50/gal U.S. Assuming a cost of $1.00/gal U.S. of D2 fuel, use of a 50 % blended biodiesel fuel would cost $2.00 to $2.25/gal U.S. This cost must be weighed against the cost of installing and maintaining emission control systems based upon filtration or other methods. It is likely that increased production of a renewable energy source, such as biodiesel, will lower costs allow biodiesel fuel to become a more viable DPM control option for underground mines in the future.

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