

Diesel Emissions Evaluation Program

Project Summary

Impact Of Low-Emission Diesel Engines On Underground Mine Air Quality

Prepared by Susan T. Bagley, Winthrop F. Watts, Jr., Jason P. Johnson, David B. Kittelson, John H. Johnson, and James J. Schauer

May 2, 2002

[Full Report](#)

[Appendices](#)

About the Study

This study was conducted at the Cote Blanche salt mine in the spring of 2000. The goal of the study was to determine if the use of modern, low emission Diesel engine technology increase or decrease the concentration of tiny exhaust particles in an underground mine. The study was funded by the U.S. National Institute of Occupational Safety and Health by a grant to Michigan Technological University (MTU). MTU conducted the study in collaboration with the University of Minnesota and the University of Wisconsin.

DEEP did not support, authorize or technically review this report and takes no responsibility for its content. DEEP, however, is providing the report on its Website because it is important for parties interested in diesel engine performance to be aware of the work.

Background: Diesel Particulate Matter Emissions

Studies have linked environmental exposure to fine particles less than 2,500 nanometers (nm) in size to adverse health effects, although no causal mechanisms have been identified. The relationship between fine particles and health is logical because the efficiency of particle deposition in the respiratory tract is a function of particle size, and very small particles are more readily deposited in the lung. Diesel exhaust is a complex mixture of exhaust gases and particulate matter. By number count most Diesel exhaust particles are very small, less than 30 nm in size, but by mass most Diesel exhaust particles are > 100 nm. Diesel engine manufactures have reduced particulate matter mass emissions to meet Federal and State regulations. However, it is not clear if the reduction in mass emissions is accompanied by a decrease or increase in the emission of tiny nanoparticles.

Test Program

This study was modeled after previous underground mine studies in which the concentration, chemical composition and physical characteristics of Diesel particulate matter were measured. Measurements were made over a two week period. During the first week mining was conducted using front-end loaders and trucks powered by older engine technology. These vehicles were replaced during the second week with modern mining vehicles with low emission engines. The same low sulfur fuel was used throughout the study.

A variety of air samples were collected to determine the changes in the biological, chemical, and physical nature of the diesel exhaust aerosol attributable to the use of low emission engines. Diesel particulate matter concentrations were determined using elemental carbon and size selective sampling techniques. The elemental carbon technique also provided information on total and organic carbon concentrations. Several near real-time instruments were used for monitoring the Diesel aerosol in the mine. These included a portable diffusion charger that determined total particle surface area, a portable photoelectric aerosol sensor for determining total surface-bound polycyclic aromatic hydrocarbons, and a condensation particle counter for determining the total particle number concentration. High-volume samplers were used to obtain samples for determination of the specific polycyclic aromatic hydrocarbons and mutagenic activity.

Results

Total and elemental carbon concentrations were reduced by at least 60% with use of the modern, low emission Diesel engines. Organic carbon levels were also reduced but to a lesser extent. The near real-time aerosol measurements showed similar decreases. This study also demonstrated that near real-time instruments like the diffusion charger, photoelectric aerosol sensor and condensation particle counter can be used to track diesel activity on a real time basis in an underground mine.

Evidence from this study suggests that the use of modern low emission Diesel engines at this mine did not introduce new air quality problems. There was no evidence of increased levels of tiny nanoparticles; in fact the total number particle concentration was reduced by 50%. Levels of polycyclic aromatic hydrocarbons and biological activity (mutagenicity) associated with the DPM also decreased by up to 90% with use of the modern low emission Diesel engines. A larger reduction in elemental carbon was observed than organic carbon at the downwind location. This finding is in agreement with what is known about low emission Diesel engines, i.e., the greatest reduction in Diesel particulate matter emissions is achieved with solid carbon particles.

Copyright © 1998-2003 Diesel Emissions Evaluation Program

[XHTML](#) | [CSS](#)