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Exposure of Underground Miners to Diesel Exhaust

Comment On: MSHA-2014-0031-0047
Exposure of Underground Miners to Diesel Exhaust , Extension of Comment Period

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Comment from Catherine Doherty, NA

Submitter Information

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General Comment

See attached file(s)

Attachments

ENV PAPER

AB86-COMM-8

November 21, 2016

Mine Safety and Health Administration
Office of Standards, Regulations, and Variances
201 12th Street South, Suite 4E401
Arlington, Virginia 22202-5452

RIN 1219-AB86
Docket No. MSHA-2014-0031

I am writing in response to the call for comment from The Mine Safety and Health Administration for more information on the exposure of underground miners to diesel exhaust. The call for comment specifics that I am writing in response to are; RIN 1219-AB86 and Docket No. MSHA-2014-0031. I am commenting on what measures could be taken to reduce mine worker's exposure to diesel exhaust. I believe that biodiesel should be used to replace diesel fuels in diesel powered mine equipment and vehicles to reduce emissions of diesel particulate matter and other toxic gaseous components of diesel exhaust.

Sincerely,

Catherine Doherty
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Underground mine work relies on the use of diesel-powered equipment and machinery, and there are many different types of vehicles that can be employed. They range from trucks that transport personnel to drills and graders. Any engine that is running on diesel fuel emits diesel exhaust or fumes, containing a mixture of toxic gases and carbon soot, which is the visible component of the exhaust (Pronk, Coble, & Stewart, 2009). This mixture can include condensed hydrocarbon gases, a complex combination of elemental carbons, and diesel particulate matter or DPM (Cohen, Borak, Hall, Sirianni & Chemerynski, 2002). Diesel particulate matter is the component of this exhaust that is particularly dangerous because it is made of tiny particles that when inhaled, will settle and deposit in the lower part of the lung. The exhaust can also include carbon monoxide and dioxide, sulphur dioxide, nitrogen oxides, and aldehydes including benzene, formaldehyde, and polycyclic aromatic hydrocarbons ("ECLOSH: Diesel exhaust," 2002), but the composition ultimately depends on the type of engine that is employing the diesel fuel, the environmental conditions, and fuel source (Cohen, Borak, Hall, Sirianni & Chemerynski, 2002).

Inhaling diesel exhaust can have adverse effects on one's health. If one is exposed to diesel exhaust they might begin to cough, have difficulty breathing, have a tight chest, and have itchy or burning eyes. These are the short term effects which will go away shortly after the worker or the person exposed has gone away from the source of the fumes. The long term effects can be serious, such as an increased risk of developing lung and bladder cancer. There is also evidence that the fine particles of diesel particulate can make heart problems and respiratory illnesses much worse ("ECLOSH: Diesel exhaust," 2002).

While other occupations expose their workers to diesel exhaust, the occupational exposure is at the highest rate in underground mines because of the lack of ventilation (Pronk, Coble, & Stewart, 2009). Because of diesel exhaust's classification as a known human carcinogen, The Mine Safety and Health Administration set a final limit of how much diesel exhaust particulate could be in the air at any given mine site (Cohen, Borak, Hall, Sirianni & Chemerynski, 2002). There are many ways to control exposure in underground mines in order to stay in compliance with this limit but better ventilation and the reduction of diesel particulate emissions from diesel-powered equipment is most commonly thought of as the most effective method to do this (Bugarski et al., 2010). Making for better ventilation in mines is simple but not effective enough, so the focus must be on how to reduce the particulate emissions from diesel-powered machinery. As mentioned before, the composition of the fumes emitted by a diesel-powered engine depends on the fuel source (Cohen, Borak, Hall, Sirianni & Chemerynski, 2002), so to reduce the emissions of toxic gases, the fuel source can be changed from petroleum based diesel fuel to biodiesel fuel (Bugarski et al., 2010).

Biodiesel is produced by a reaction of a renewable lipid source, such as vegetable oil or animal fat, with methanol or ethanol under heat; this process is called transesterification (Bowman, Hilligoss, Rasmussen, & Thomas, 2006). This chemical reaction yields glycerin and biodiesel which is also known as alkyl ester (Howell & Weber, 1996). The discovery of this new fuel came about as a result of a search for an alternative to petroleum based fuels because of a fear of fossil fuel shortages since fossil fuels are a non-renewable resource (Pinto et al., 2005). This alternative and renewable source has been registered as a pure fuel with the Environmental Protection Agency and is a legal fuel for commerce (Howell & Weber, 1996).

Although the biodiesel industry focuses primarily on underground mining because of the need for methods to decrease the occupational exposure to underground mine workers of diesel particulate matter, biodiesel can be used to replace diesel in all diesel powered equipment or vehicles in all occupational work sites or even just for commercial use ("Mining," n.d.). An example of its commercial use is Willie Nelson taking advantage of this environmentally friendly fuel alternative and making it available for others as well. Nelson has been known to hitch a fuel tank to the back of his large tour bus while traveling from venue to venue so he can refuel the bus using biodiesel. He even started his own company, Willie Nelson's Biodiesel, which sold its BioWillie (his name for his biodiesel) to truck stops and gas stations (Bowman, Hilligoss, Rasmussen, & Thomas, 2006).

Using biodiesel in place of regular diesel was found to greatly reduce emissions of diesel particulate matter (Bugarski et al., 2010). It also eliminates the thick black exhaust, or carbon soot, that is produced by petro-diesel fuels which allows for more visibility in underground work sites such as underground mines (Bowman, Hilligoss, Rasmussen, & Thomas, 2006). Although biodiesel is sometimes criticized to be cost prohibitive, the advantages weigh out this disadvantage greatly. If using it in it's pure form is too expensive it can be used as an additive and be blended with petroleum based fuels. Mixing the two isn't as effective as using biodiesel in its pure form but levels of particulate output will still be reduced. Biodiesels reduction of particulate matter has been proved when testing in the field as well as in the lab. Its use has been recorded to reduce particulate matter emission to 50% when using its pure form as compared to diesel fuel, so depending on the proportions of a biodiesel and petro-diesel mixture, the engine type, and filtration systems, one could calculate the percentage of diesel particulate matter being emitted from the engine being used. Also, biodiesel can be used in new or already existing technology which means new technology doesn't need to be employed or invested in to take advantage of this alternative. Blended or in it's pure form, biodiesel works very similarly to petroleum based diesel fuels when operating an already existing diesel or compression ignition engine technology. It's use in existing technology will not create a hindrance on the performance of the equipment. Biodiesel works great in new equipment technologies as well because it reduces the emissions of solid carbon component of diesel particulate matter, while the sulfate component is eliminated, and the soluble component stays at the same level or sometimes increases. Because catalysts decrease the output of the soluble component of diesel particulate, biodiesel is a quite compatible match for this technology. It also can promote longer engine lives for engines that recirculate engine exhaust because of the lower concentration of carbon (Howell & Weber, 1996).

Another advantage of the use of biodiesel is that it makes the use of diesel particulate filters more attractive (Bugarski et al., 2010). They are utilized commonly to reduce the exposure of particulate matter to workers in underground mines but are not used as much as they could be because they are complex and expensive. A diesel particulate filter is a device that removes diesel particulate matter and the soot from diesel exhaust from a diesel engine. This removal can occur passively or actively and this is called regeneration. Passively, the removal process occurs because of the heat of the diesel exhaust during the operation of the engine or by adding a catalyst to the diesel particulate filter ("Diesel particulate filter," 2016). The use of biodiesel with diesel particulate filters (DPF) can promote regeneration in the in DPF systems because of underground mines tendency to have a low balance point temperature. This can eliminate extra expenses related to DPFs and negate the need for active regeneration of the filters (Bugarski et al., 2010). Biodiesel also has a higher cetane number (Howell & Weber, 1996). Biodiesel has a higher cetane which is an indicator of the combustion speed of diesel fuel and combustion is what is needed for ignition. The cetane number is important when determining the quality of a diesel fuel. Therefore, biodiesel is a better quality fuel than conventionally used fuels ("Cetane number," 2016).

There are even more advantages to using biodiesel as an alternative to conventional petro-diesel fuels. These positively affect not only the mine workers who are being spared an occupational hazard, but also the whole world. Biodiesel requires less energy to produce (Bowman, Hilligoss, Rasmussen, & Thomas, 2006), is much less toxic to humans and the use of alternative fuels can also reduce our dependence on foreign fuel supply, create domestic manufacturing jobs and is a good way to reduce CO_2 emissions into our atmosphere (Howell & Weber, 1996).

Petroleum based diesel fuel is already harmful enough to our planet and to humans when it comes to its emissions alone, but its production puts another burden on our environment. Producing biodiesel requires much less fossil fuel energy to produce. It has been found that for every one unit of fossil fuel it takes to produce biodiesel, 3.2 units of fuel energy are generated by its use (Bowman, Hilligoss, Rasmussen, & Thomas, 2006). It's use also emits less carbon dioxide. A vegetable whose oil is being used to produce biodiesel will take in carbon dioxide while it is growing. When the oil is taken from the vegetable and is refined, the CO_2 is in that oil and when that oil is burned the carbon dioxide gets released back into the atmosphere. Although carbon dioxide is being released into the atmosphere, it is not adding any extra because the next vegetable will use that CO_2 when it is growing. When petroleum based diesel fuels burn they also release carbon dioxide into the atmosphere but in this case it is adding more CO_2 that would not have already been present from the vegetable. Biodiesel also contains oxygen, 11% to be exact, which allows the fuel to burn more completely leaving less toxic gases in the air (Bowman, Hilligoss, Rasmussen, & Thomas, 2006).

Even though biodiesel is much safer for humans and the environment than regular diesel fuel, it must still be handled and stored the same as regular diesel. This means that it must be stored in a clean, dry, dark environment and should not be exposed to temperature extremes. Over time, biodiesel will degrade certain types of natural rubber compounds and elastomers, so fuel pump seals and other storage or distribution equipment cannot contain these compounds or else there will be leaking (Howell & Weber, 1996).

Using biodiesel to power otherwise diesel powered equipment and vehicles in underground metal and nonmetal mines could substantially reduce the concentrations of diesel particulate matter in mine air (Bugarski et al., 2010). And while it can be expensive to utilize, it should be used as much as possible for the sake of the underground mine workers' health in addition to the health of our environment in general.

Catherine Doherty Biodiesel: Reducing Diesel Exhaust Exposure November 21, 2016

Annotated Bibliography

Aleksandar D. Bugarski , Emanuele G. Cauda , Samuel J. Janisko , Jon A. Hummer & Larry D. Patts (2010) Aerosols Emitted in Underground Mine Air by Diesel Engine Fueled with Biodiesel, Journal of the Air & Waste Management Association, 60:2, 237-244, DOI: 10.3155/1047-3289.60.2.237

This journal explores the use of biodiesel in place of petroleum diesel in underground mines in an effort to reduce underground mine-worker's exposure to carcinogens. A study was set forth to compare the effects of biodiesel fuel and petroleum fuel using a mechanically controlled diesel engine that had a muffler and diesel oxidation catalyst. This experiment was carried out in an experimental underground mine. When this engine was running on biodiesel, it produces less elemental carbon concentrations than the engine did running on petroleum. Bugarski et al. goes into a lot of detail about experimental methodology, measurements, carbon concentrations, mass and number concentrations, and size distribution. They produce a lot of data, figures, graphs, and tables to support their arguments when related to the aspects they went into mentioned above. This piece was very informative and helpful with its extensive detail.

Bowman, M., Hilligoss, D., Rasmussen, S., & Thomas, R. (2006). Biodiesel: a renewable and biodegradable fuel. Hydrocarbon Processing

Bowman, Thomas, and Rasumussen talk about biodiesel as a replacement for or additive to regular diesel fuel. They cover the benefits, production, and other important aspects of this argument such as human health effects. Because biodiesel should be so attractive to the occupational world as well as the commercial world, they believe that biodiesel should be produced to the highest purity standard possible.

Cetane number (2016). . In Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Cetane_number

This is an encyclopedia entry that discusses the definition, typical values, additive, and the chemical relevance of cetane and how to measure the cetane number as well as its connection to alternative fuels.

Cohen, H. J., Borak, J., Hall, T., Sirianni, G., & Chemerynski, S. (2002). Exposure of miners to diesel exhaust particulates in underground Nonmetal mines. *AIHA Journal*, *63*(5), 651–658. doi:10.1080/15428110208984753

They examine a study of seven nonmetal mines that shows that worker's exposure to diesel particulate matter consistently exceeds the limit that was set by the Mine Safety and Health Administration. They also try to examine how good diesel exposures can be measured in underground mining environments and explore the types of monitoring and measuring that can be implemented.

Diesel particulate filter (2016). . In *Wikipedia*. Retrieved from https://en.wikipedia.org/wiki/Diesel_particulate_filter

This encyclopedia entry explains and defines diesel particulate filters.

ELCOSH: Diesel exhaust. (2002). Retrieved November 21, 2016, from Electronic Library of Construction Occupational Safety and Health, http://elcosh.org/document/1743/d000609/diesel-exhaust.html

This is a piece put out by the Construction Safety Association of Ontario that went into the topic of diesel exhaust and its possible long term and short term health effects. It also gave some advice to be followed on the job site to limit the occupational exposure to diesel exhaust.

Howell, S., & Weber, J. A. (1996). Biodiesel Use in Underground Metal and Non-metal Mines.

Biodiesel isn't always the first thing that people think of as an alternative to petroleum diesel even though biodiesel isn't a new fuel. It has actually been around a long time but people tend to shy away from it because it is more expensive than regular fuel. Even though this fuel isn't thought of usually for commercial use, it is starting to become a way for mining companies to limit the amount of diesel fumes they are exposing their workers to.

Mining. Retrieved November 21, 2016, from BIODIESEL, http://biodiesel.org/using-biodiesel/market-segments/mining

This online marketing piece gives some background to the mining industry and why biodiesel is so important to this industry.

Pinto, A. C., Guarieiro, L. L. N., Rezende, M. J. C., Ribeiro, N. M., Torres, E. A., Lopes, W. A., … Andrade, J. B. de (2005). Biodiesel: An overview. Journal of the Brazilian Chemical Society, 16(6b), 1313–1330. doi:10.1590/s0103-50532005000800003

This overview on biodiesel discusses the importance of biodiesel production based on scientific journals and patents. Some main reasons for its production include possible future shortages of fossil fuels, and the emissions of fossils fuels compared to the emissions of biodiesel. It also goes into the general view on the production of biodiesel, and source for its production, and other things that must be considered in regards to its production.

Pronk, A., Coble, J., & Stewart, P. A. (2009). Occupational exposure to diesel engine exhaust: A literature review. Journal of Exposure Science and Environmental Epidemiology, 19(5), 443–457. doi:10.1038/jes.2009.21

The purpose of this article is to find the most common occupational uses of diesel engines and determine which occupations exposed their workers to diesel exhaust the most by abstracting data from published literature. The agents they looked at to explore this data was elemental carbon, particulate matter, carbon monoxide, nitrogen oxide, and nitrogen dioxide, and were measured in on and off road diesel powered vehicles. It was reported that underground work sites, such as mines, had the highest level of exposure to diesel exhaust and the exposure at these sites depended on ventilation and exhaust after treatment devices.