

Diesel Emissions in Underground Mining

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Presentation Outline

- What is the U/G Diesel Emission problem?
- Work to-date
- Solutions
- Next Steps: Implementation of Solutions and Further Work



Carcinogenicity of DPM (Diesel Particulate Matter)

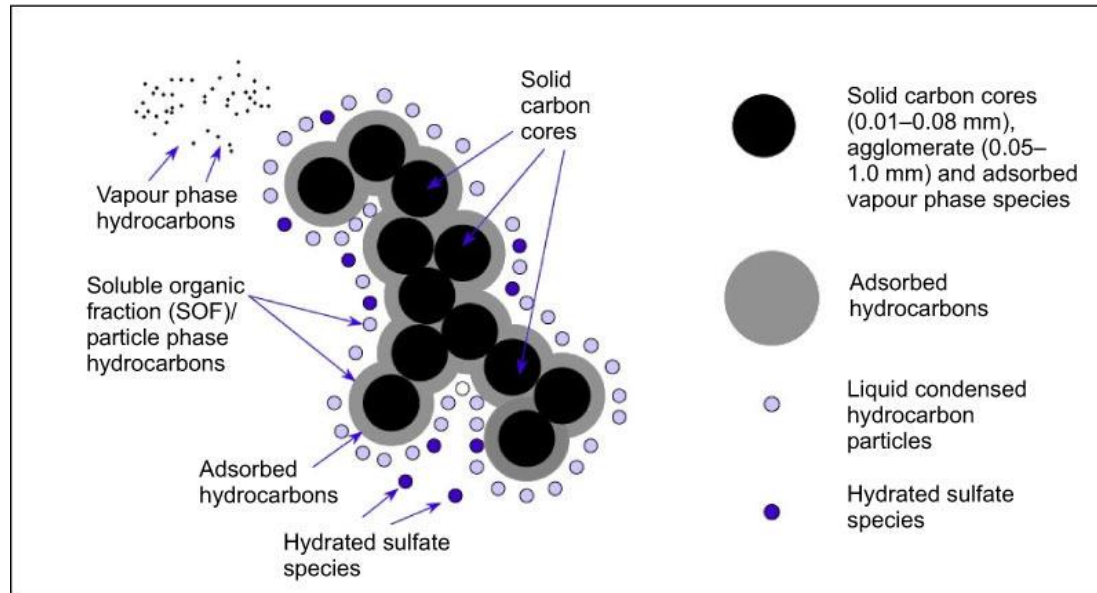
- In March 2012 the NIOSH and NCI 20-year *'Diesel Exhaust in Mines Study report was published*

It involved a cohort mortality study of 12,315 mineworkers at 8 US underground non-metal mines.

- **it indicated** a strong link between the **level of exposure** and **risk of lung cancer** mortality.
- The **mortality rates** for those at higher exposures were **3 to 5** times greater compared to those at lowest exposures. (National Cancer Institute 2012)
- National Cancer Institute 2012; Heavy exposure to diesel exhaust linked to lung cancer death in miners, March 2, 2012, pages 1-2

What is the Diesel Emission problem?

Diesel Particulate Matter



- Most of the mass is composed of carbonaceous agglomerates
- The particles have hundreds of chemicals, HCs adsorbed onto their surfaces, including many known or suspected mutagens
- Mass median diameter is 0.2 micrometer at this size the deposition to respiratory track is ~ 20 %

Key issue/challenge

- Diesel engines produce up to 100 times more particulate matter (PM) compared to petrol engines. They also produce smaller particles, including **ultrafine particles in the nanoscale range**, which allow for **deeper penetration into the lungs** (Lucky Joeng et al 2013)
- In 2006 the California Air Resource Board estimated that diesel exhaust pollution directly accounted for 2,400 deaths and nearly 3,000 hospital admissions annually for respiratory related diseases.(Ifan Odwyn Jones 2015)

Lucky Joeng et al, 2013 :validation of the dynamic direct exposure method for toxicity of diesel exhaust in Vitro; ISRN Toxicology, Volume 2013, Article ID 139512, 11 pages

Ifan Odwyn Jones, 2015; health challenge facing underground hard-rock mining, Australian Mining, pages 1 – 5, feb 27, 2015

Carcinogenetic of DPM

In June 2012 the IARC -International Agency for Research on Cancer (part of the WHO) classified **Diesel Engine Exhaust as carcinogenic** to humans (Group 1)

This landmark study was informed on the lung cancer risk for the underground mine workers, but the finding suggest that the risk may extend to other workers exposed to diesel exhaust...(National Cancer Institute, 2012)

IARC (World Health organization) , Press Release N 213 – Diesel Engine Exhaust Carcinogenic, pages 1 to 4

National Cancer Institute , 2012: Heavy exposure to diesel exhaust linked to lung cancer death in miners, March 2, 2012, pages 1 to 2

What is the Diesel Emission problem?

Challenges

It would not be economical nor technically feasible to achieve targeted levels by increasing the ventilation rate (100cfm / BHP)

DPM needs to be controlled at the source.

The effective DPM reduction strategy appears to be diesel particulate filter (DPF) systems coupled with:

- good ventilation practices
- adherence to well planned maintenance program
- use of low emission engine technology
- use of high quality fuels and lubricants

DEEP- Diesel Emissions Evaluation Program

- DEEP focused on the importance of good ventilation practices, well planned maintenance, filter technology, use of high quality fuels and lubricants and measurement methods.
- 4 years –over \$2.5M evaluation of 9-nine state-of-the art DPF system retrofitted to heavy and light duty underground mining vehicles

DERR Stakeholders

- Labor
 - Canadian Auto Workers
 - Unites Steel Workers of America
- Industry
 - Barrick Gold
 - Inco (Currently Vale)
 - CAMIRO,
 - Falconbridge (currently Glencore)
 - Hudson Bay Mining and Smelting
 - IMC Kalium
 - Noranda (currently Gkencore)
 - Place Dome Canada (currently Goldcorp)
 - Williams Op. Co. (currently Barrick Gold)
- Supplier
 - Ontario Soybean Growers
 - Saskatchewan Canola Dev. Corp.
 - North Dakota Canola
 - Diesel Engine Manufacturers
 - Manufacturers of Environmental Controls Association
- Government
 - Association of Chief Mine Inspectors
 - Natural resources Canada
 - Ontario WSIB
 - New Brunswick WHSCC
 - Manitoba WCB
- Outside linkages
 - VERT (Europe)
 - Kali und Saltz (Germany)

Breakthrough/Results – 99% elimination of Diesel soot

- **The light duty applications** selected proved to be a practical solution.
 - Vale has 30 light duty DPF units operating on tractors, locomotives and light duty trucks
- **The heavy duty application:**
 - Unit successfully eliminated 99% over accumulated 2000 hrs
The unit was removed and a spare unit re-installed within one shift
 - The LHD is currently in the normal production fleet

J. Stachulak and C. Allen ;A History of Diesel Emission Program at Vale Ontario Mines, MDEC, Toronto, Oct. 2015

Recommendation – Path forward

- Applied research is urgently required to consolidate the diesel curtailment breakthrough
- Research partners ?? Canadian , International



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