Respirable Dust
Past, Present and Future

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Respirable Coal Dust

- What is it?
- Where does it come from?
- What effects does it have on Coal Miners?

Look at the Past, Present and Future

- Regulations
- Controlling Coal Dust
- Monitoring Coal Miner’s Exposure

What is Respirable Coal Dust?

- **30 CFR § 70.2(n)** - ***Respirable dust*** means dust collected with a sampling device approved by the Secretary and the Secretary of Health and Human Services in accordance with part 74 (Coal Mine Dust Personal Sampler Units) of this title.
- ***Coal Mine Dust –*** a mixture of coal, silica, pyrite, clays and other organic materials
- ***Respirable Coal Dust*** consists of very small particles that can be inhaled and deposited in the lungs, and that presents a health hazard if not adequately controlled.

Where does Coal Dust come from?

- Cutting coal from the face
- Loading cut coal
- Drilling
- Crushers / Feeders
- Belt conveyors / Transfer points
- Shield movement on longwalls
- Blasting
- Equipment traveling on haul roads
- Intake contamination

What effects does it have on Coal Miners?

- Health hazards of breathing coal mine dust include Coal Worker's Pneumoconiosis (Black Lung), Silicosis, and Chronic Obstructive Pulmonary Disease (COPD)
- Depends on several factors including how much and how long it is breathed.
- Affects the coal miner's respiratory system

Human Respiratory System

- System where the body absorbs oxygen and eliminates carbon dioxide
- Consists of the nose and mouth, windpipe, bronchial tubes, lungs, bronchioles and alveoli (tiny air sacs)
- The respiratory system has defense mechanisms, such as a mucus lining and cilia, which help rid the body of foreign objects (larger dust particles)
- The alveoli, where the oxygen exchange takes place, are protected by special cells called microphages which try to digest the very smallest dust particles.
- Coal dust and silica can damage the microphages.

Human Respiratory System

- Respirable dust, that can enter the alveoli, measures less than 10 microns.
- The human eye can see particles as small as 40 microns.
- Visible dust is greater than 40 microns.
- Damaging respirable dust is not visible to the human eye.

Coal Workers Pneumoconiosis
Black Lung

- Caused by coal dust that accumulates in the lungs
- The lung tissue reacts to the coal dust reducing the efficiency of the lungs
- The defense mechanisms of the respiratory system become less effective

Silicosis

- Silicosis is a type of pneumoconiosis caused by inhaling quartz (free crystalline silica)
- More serious than coal workers pneumoconiosis
- Lung's defense against silica causes fibrous tissue to form in the lungs which destroys the ability of the lungs to do their job
- Silicosis can destroy the lungs faster than CWP

Regulations - Past

- Coal dust was not recognized as a danger until the early 19th century, but silicosis was thought to be the cause of coal miners lung disease
- In 1910 The U.S. Bureau of Mines was formed to investigate mine explosions and conduct research to reduce accidents and improve mining methods and conditions in the nations coal mines.
- In 1934 Britain recognized that coal dust was a cause of a progressive and fatal disease
- Not until 1969 did the United States officially recognize coal dust as a health hazard separate from silica.

Regulations - Past

- The Federal Coal Mine Health and Safety Act of 1969
  - Provided for accurate dust sampling with a sampling unit approved by the Secretary.
  - For the first 3 years the coal mine dust standard was set at 3.0 mg/m^3, and then reduced to 2.0 mg/m^3, which remains the standard today.
  - Provided for chest X-rays for miners and an option for miners showing evidence of pneumoconiosis to work in a less dusty environment with a reduced standard concentration.
- The Federal Mine Safety and Health Act of 1977
  - Provided the authority of the Mine Safety and Health Administration to establish and enforce a respirable coal mine dust standard as provided in Title 30,CFR Part 70

Regulations - Present

- **Title 30 CFR, Part 70**
  - Establishes a respirable coal mine dust standard of 2.0 mg/m^3, unless quartz is present.
  - When the dust contains more than 5% quartz, a reduced standard is determined by dividing the % quartz into the number 10.
  - Provides for a dust standard of 1.0 mg/m^3 for intake air
  - Requires mine operators to collect and submit 5 dust samples from a designated occupation during each bimonthly sampling period.
  - Operators are required to develop and submit a Dust Control Plan to be approved by the MSHA District Manager that sets the minimum parameters to be used to control dust below the standard concentration.

Regulations - Future

- Further reducing the coal mine dust standard – There is debate regarding if it is necessary
- New continuous personal dust monitor sampling devices such as the PDM
- Changing regulations to incorporate new technology – over 30 years later

Controlling Coal Dust - Past

- Ventilation originally was not recognized as a means to remove harmful contaminants
- Limited ventilation was provided mostly to help control methane accumulations….and keep the canary alive.
- Early days of coal mining - Ventilation was provided by natural draft, then by furnaces installed on the return shafts, followed by mechanical fans powered by steam first, then by electricity in the 20th century
- Getting the limited amount of air to the face areas where the coal was being mined was challenging

Controlling Coal Dust - Past

- Conventional mining was the early mining method
- In the mid 1900's continuous mining presented new ventilation and dust control challenges.
- Water was starting to be used for limited dust control.
- Blowing ventilation was being used for better methane control, but it was not as good for controlling coal dust
- In 1969 the Act forced operators to begin to more effectively control respirable dust.
- Exhaust ventilation became more prominent
- Research was conducted using diffuser and exhaust fans, as well as early scrubbers

Controlling Coal Dust - Present

- Bigger equipment and more production provide the challenges for dust control today
- Longwalls produce as much in a shift as entire mines produced in weeks or months in the earlier days of mining
- Continuous miner production has increased to stay ahead of the longwalls
- NIOSH conducts research to continue to find more effective ways to control coal mine dust
- Engineering and administrative controls, as well as personal protective equipment (PPE) can be used to control exposures

Controlling Coal Dust - Present

- Dust Control Principles
  - Prevent the generation of dust
  - Removal the dust from the atmosphere
  - Suppress the dust before it enters the miner's breathing zone
  - Isolate the miner from the dust
  - Dilute the dust to lower concentrations

Controlling Coal Dust - Present

- Continuous Miner Dust Control Methods
  - Water spray design and location
  - Remote control
  - Machine mounted scrubbers
  - Spray fan
  - Cutting sequence
  - Ventilation – Blowing, Exhaust, Auxiliary fans
  - Roof Bolter dust controls
  - Outby contamination controls – damp haul roads, sprays at feeder / crushers and transfer points

Controlling Coal Dust - Present

- Longwall Mining
  - Longwalls present different sources for dust generation
  - Shearer cutting, shield advance, crusher and stageloader, coal transfer points, intake air contamination
  - Larger quantities of fresh air at higher velocities
  - Larger quantities of water for dust control and cooling water

Controlling Coal Dust - Present

- Longwall Dust Control Methods
  - Water spray design and location on the shearer
  - Shearer Clearer / directional water sprays
  - Remote control shearer and shields
  - Stage loader mounted scrubbers
  - Shield water sprays, on top of the shields and water curtains
  - Cutting sequence / automation
  - Ventilation – proper quantities, cut out curtains
  - Water infusion
  - Surfactants / additives
  - Outby contamination controls – damp haul roads, sprays at feeder / crushers and transfer points
  - Administrative controls / worker positioning
  - PPE – NIOSH approved Powered Air Purifying Respirators

Controlling Coal Dust - Future

- Dust control challenges abound as production continues to increase both on continuous miners and longwall sections, and equipment continues to get bigger and more powerful.
- Longwall faces are getting longer, requiring more air and volumes of water for dust control
- Automation should continue to become more reliable and practical, reducing dust exposure to the miners
- Shield water sprays / water curtains offer promising results for better dust control.
- Water infusion should become more common as more mines use horizontal degas holes to reduce methane liberation prior to longwall mining

Controlling Coal Dust - Future

- Stage loader scrubbers can capture dust that could effect the exposure of everyone down wind of the stageloader.
- New additives may be developed that are economical and effective when mixed with the water used to suppress dust
- NIOSH will continue to do important research to find better ways to control dust and protect the miners.
- Regulations may change to recognize advances in new technologies for personal real time dust monitoring and personal protective equipment.

Monitoring Coal Miners Exposure - Past

- Prior to the Federal Coal Mine Health and Safety Act of 1969, operator sampling for respirable dust in coal mines was not required.
- Research had been done by the U.S. Bureau of Mines since the 1930's on several types of sampling instruments that used different techniques to measure dust.
- Early samplers counted particles of dust, generally a micrometer in size
- During the 1960's researchers started to realize that the smaller particles, under 10 microns, were the ones getting deep into the lungs causing the disease.

Monitoring Coal Miners Exposure - Past

- The Mining Research Establishment (MRE) gravimetric sampler utilizing an elutriator was developed in the United Kingdom in 1964.
- In the U.S. a “personal” sampling device that used a 10 mm nylon cyclone was developed utilizing the same principle as the MRE instrument.
- Slight differences in the size range of the dust separated by the wearable personal sampler compared to the larger MRE device required a method to correlate the dust concentration of the two samplers.
- This led to the 1.38 correction factor that is still used for comparison of the cyclone device to the MRE device.

Monitoring Coal Miners Exposure - Past

- Past history has provided some controversy over the reliability of properly collecting the dust samples.
- Accusations of tampering with the samples raised questions as to the reliability of the sampling data.
- Changes were made to the sampling cassettes to help eliminate some of these concerns.

Monitoring Coal Miners Exposure - Present

- Not much has changed with the gravimetric samplers in the past 40 years, but the quality of the sampler design has served it well.
- Real time sampling technology was looked at in the 1990's with machine mounted sampling units, but the accuracy of these instruments caused concern.
- In the early 2000's true personal sampling with a wearable personal dust monitor (PDM) was being developed

Monitoring Coal Miners Exposure - Present

- 30 CFR Part 74 defines the requirements for approval of coal mine dust personal sampler units
- 30 CFR Parts 70, 71 and 90 define the health standards for underground coal mines, surface areas of underground coal mines, and protection for miner's who have shown evidence of the development of Coal Worker's Pneumoconiosis
- The operator is required to collect 5 valid samples from the designated occupation on each mechanized mining unit each bimonthly
- While the sampler is worn by the miner, the D.O. samples the respirable dust in the area where the miner operates his equipment in a mechanized mining unit
- Samples are also required to be taken in designated areas as shown in the mine ventilation plan to measure concentrations in outby areas.
- Part 90 miners are sampled each bimonthly

Monitoring Coal Miners Exposure - Present

- All samples taken are sent to a specified lab to be evaluated and weighed to determine weight gain which can be converted to the average concentration
- Sampling is used to determine whether the minimum parameters, as defined in the mine's methane and dust control plan, continuously effectively reduce the concentration of respirable dust in the atmosphere to below the standard.
- The results of the samples often are not known for 7 to 10 days after the samples are submitted.
- While the operators are required to provide PPE to miners, no credit is given for wearing PPE towards complying with the dust standard, even in abnormal situations or conditions.
- NIOSH collects data from miner's chest X-rays taken in the NIOSH Coal Workers' Health Surveillance Program

Monitoring Coal Miners Exposure - Future

- The law sets forth the requirements for sampling devices, sampling procedures and rules for setting the dust standard.
- Changes in monitoring and sampling for respirable coal dust would require changes in the law. This is not easily accomplished.
- Most agree that real time sampling devices should be utilized in future respirable dust sampling
- It may now be time to take another look at the original sampling methods with the development of new technologies, and to upgrade the present system to the 21st century.

Monitoring Coal Miners Exposure - Future

- In the early 2000's a partnership was formed between the UMWA, BCOA, NIOSH and R&P (now ThermoFisher Scientific), manufacturer of the PDM, to test the devices in coal mines, get feedback from the miners, and develop a strategy to go forward with the PDM.
- In 2007 the UMWA and BCOA came to agreement on some key issues for moving forward with implementation of the PDM
- During 2008 the agreed upon principles were presented to MSHA, NIOSH and the National Mining Association.
- The PDM is on display at MINExpo 2008 in the exhibit hall at ThermoFisher Scientific's booth #667

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Thank You