Continuous Miner Dust Suppression

Anglo American Coal

The Problem

Coal workers' pneumoconiosis is a potentially life threatening disease which was thought to have been eliminated in Australia. Between May 2015 and July 2016 there have been 22 confirmed cases in Queensland.

Personal sampling occurs as a constant effort to measure and verify exposure limits in the work place. The Queensland underground coal mining industry recognised that some form of intervention and improvement was required. Grasstree Mine was no different and embarked on reducing respirable dust across all of its processes: Longwall, Development and Outbye. During 2016, in the Development panels prior to any action being taken a total of 150 personal dust samples were taken with 13 exceeding the equivalent exposure limit.

The Solution

Figure 1 – Integrated Hungry Board Curtain Spray

The basic principle of the dust suppression solution on the continuous miners is to implement engineering controls that isolate the workers from the source of dust; thereby forming a safe working area during the production sequence.

The integrated hungry board spray has taken the principles of a curtain spray bar together with a protection device for the hydraulic hose and amalgamated them into a robust compact unit. The angled design is to prevent build-up of material on the spray bar to ensure reliability of the dust suppression controls as well as buffer protection around the sprays to prevent damage to the actual spray nozzle. The design of the block was to sit flush against the roof bolting rig hydraulic bank at the front of the miner to prevent failure of the hydraulic 5-1 hoses due to material damage.

Internal engineering resources were used to design and draft technical drawings to send to an external manufacturer to manufacture the internal spray bar as well as mould the poly block. The internal spray bar is design rated for a pressure of 2500 kPa, mine supply fire-fighting water pressure is 1450-1700 kPa. The material choice of polyethylene was to ensure that a robust and durable design was maintained. Due to the proximity of the spray bar to the cutter head there is a high chance of rock falling and damaging equipment in that area.

The most recent modification to the miner spray circuit is the introduction of the Enviromist 100 bar circuit which consists of the addition of a hydraulic intensifier pump and externally designed manifolds and spray nozzles as per Figure 2. The hydraulic circuit was designed on site to provide control of water usage and pressure in circuit. Ultimately the usage at the spray is dependent on the requirements indicated by the mining conditions.

The incorporation of the high pressure spray manifold mounted to the cutter head allows the application of the sprays on the fly cutter at all times whereas the previous spray design was mounted to the stationary shovel therefore with the heads elevated, limiting dust suppression while cutting.

The conveyor sprays at the front and rear of the header tank add to the natural ventilation by increasing the velocity to the face via the chain guide, forcing dust towards the ventilation tube with the existing dust controls.

Figure 2 – Enviromist 100 Bar spray Circuit

The method used in trialling and testing the effectiveness of the change was to establish baseline data and measure the effective change of each modification by using real time dust monitors (PDM3700). The PDM's take a dust concentration reading each minute allowing any non-production data to be removed (in the data analysis stage) to ensure data is reproducible and able to be compared. Four PDM3700 units were used during the testing stage and placed in the following configuration (Figure 3).

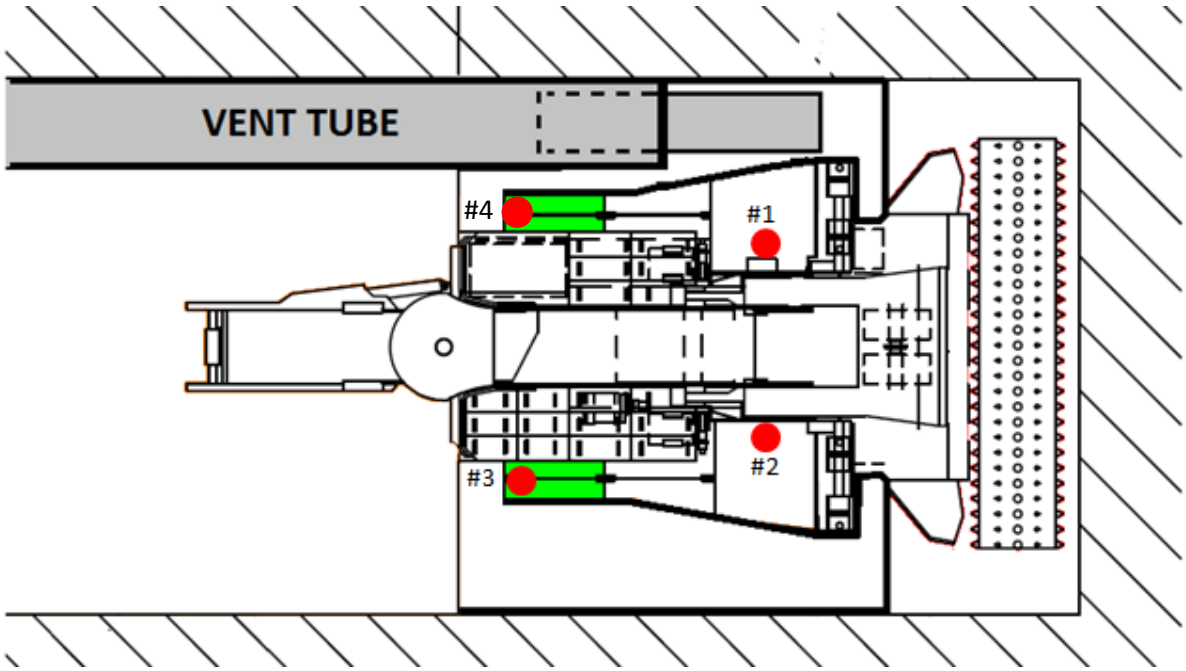


Figure 3 – Real Time Dust Monitor Positions

The installation of the system has been done both onsite and during the overhaul process of the integrated hungry board curtain spray. The spray attaches to the top protective plate of the traverse cylinder with minor modifications made to the plate. Initially, the prototype was installed on one miner within the fleet to verify the fit and application of the spray bar. Changes were then made to modify the spray as per Figure 1. This spray will be implemented across the entire continuous miner fleet by June 2017.

The hierarchy of control has been applied through engineering and administrative controls. Engineering control via the integrated hungry board curtain spray. Administrative control via the introduction of designated standing areas during specific modes in the sequence, plus the mandatory use of a P2 dust mask or better while in production.

Benefit/Effect

Since the implementation of the initial dust control strategy starting in June 2016, there have been zero respirable dust exceedances, therefore we have reached our initial goal of zero exceedances.

Table 1 below outlines a summary of the real time dust monitoring completed throughout each trial. And the following Graphs 1-4 show the progression of the results in more detail for each monitor position on the continuous miner.

Trial 0:

No dust suppression – only frictional ignition sprays

Trial 1:

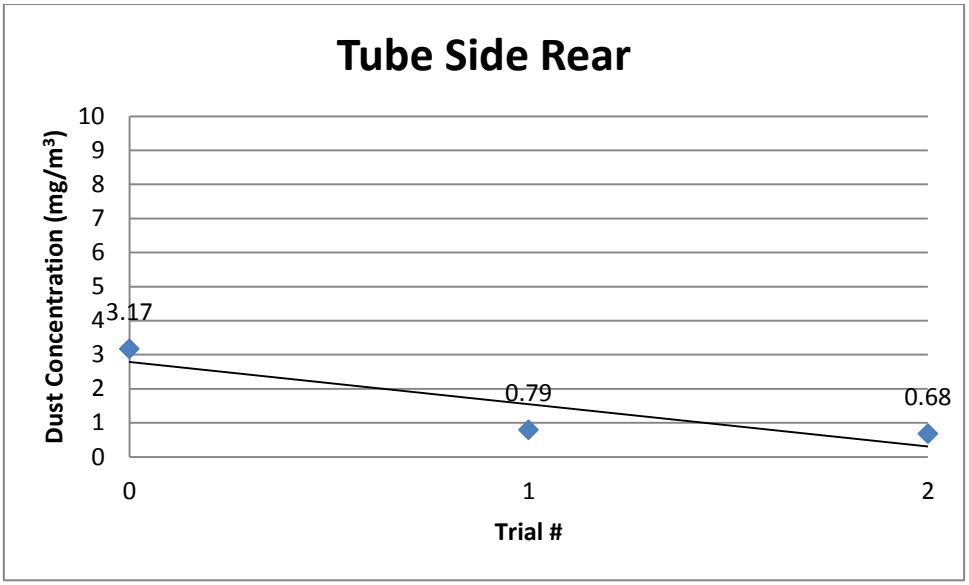
Initial dust suppression implemented - Initial curtain spray design – block style, tail sprays and conveyor Sprays

Trial 2:

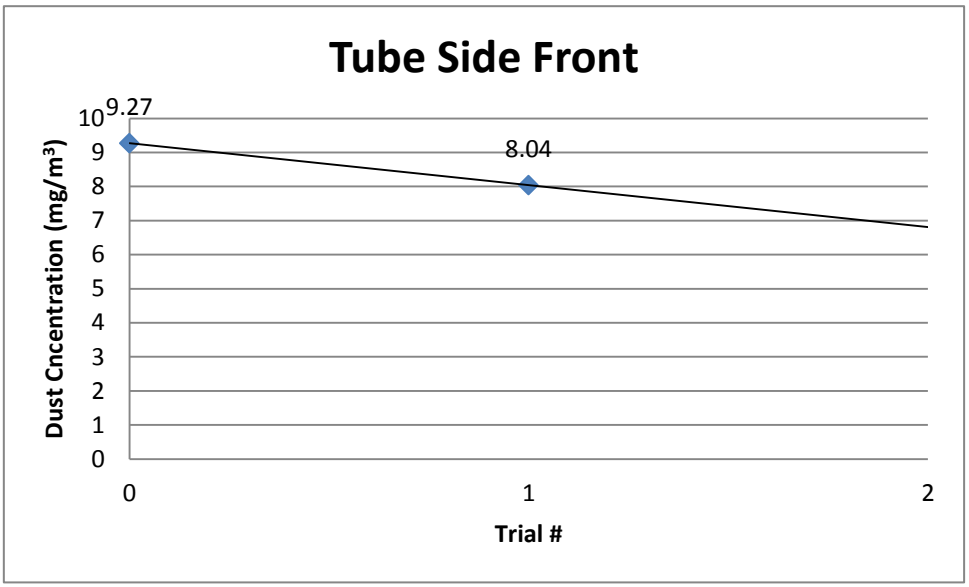
Modified dust suppression - Integrated hungry board curtain sprays, air atomising tail sprays and air atomising conveyor sprays.

Table 1: Summary of Testing Results

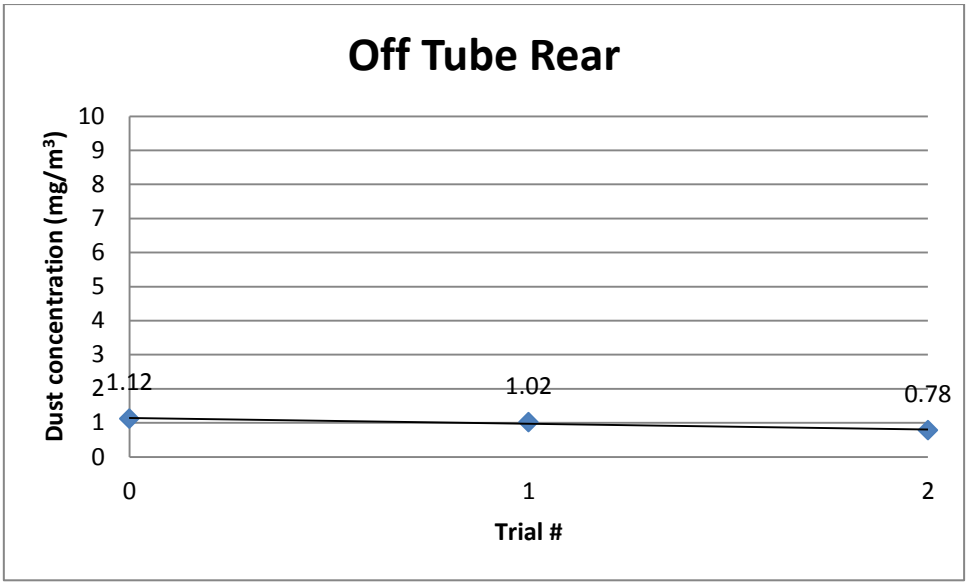
	OFF TUBE FRONT	OFF TUBE REAR	TUBE SIDE FRONT	TUBE SIDE REAR
PERCENTAGE IMPROVEMENT	79.64%	30.36%	13.27%	78.55%



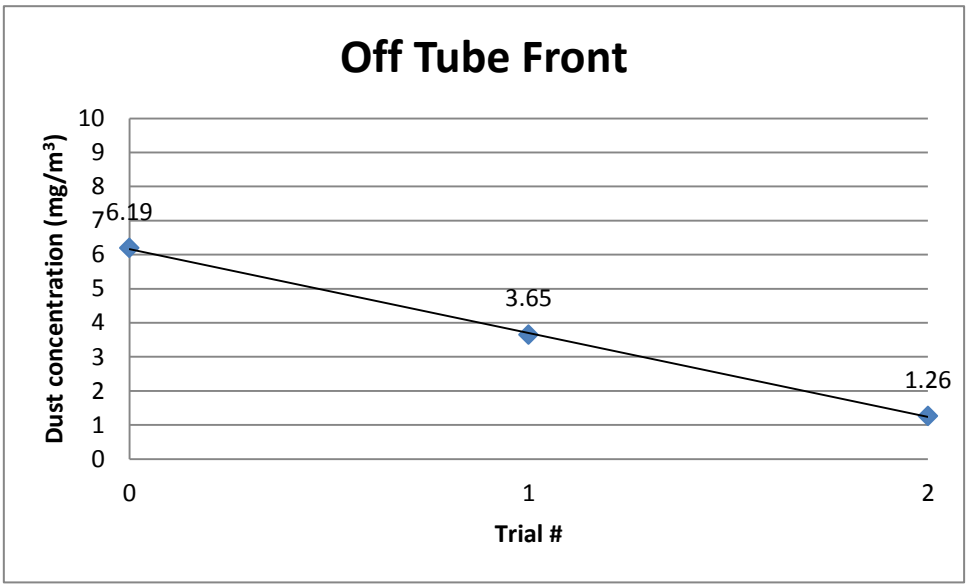
Graph 1 – Tube Side Rear Dust Concentration Results



Graph 2 – Tube Side Front Dust Concentration Results



Graph 3 – Off Tube Rear Dust Concentration Results



Graph 4 – Off Tube Front Dust Concentration Results

Transferability

The design currently can be implemented in any development panel at an underground – granted modifications may be needed depending on the particular machines. Upon sharing our data with other sites within the Anglo group, there are plans to implement the integrated hungry board curtain spray on the other continuous miners.

After presenting the improvements to the safety leaders of the Anglo group there have been discussions to take the design and transfer the principles to implement in dust reduction of loading coal into a hopper at the coal preparation plant (since the design integrates dust suppression as well as protection of the sprays which in turn increases the reliability of the dust suppression and reduces maintenance).

Innovation

The integrated hungry board spray has taken the principles of a curtain spray bar and a protection device for the hydraulic hose and amalgamated them into a robust compact unit. The angled design is to prevent build-up of material on the spray bar to ensure reliability of the dust suppression controls as well as buffer protection around the sprays to prevent damage to the actual spray nozzle. The design of the block was to sit flush against the roof bolting rig hydraulic bank at the front of the miner to prevent failure of the hydraulic 5-1 hoses due to material damage.

The curtain design was employed as opposed to wetting the coal with large amounts of water, to redirect the dust created from the cutter head away from the workers and through the ventilation tube and into the return airways. The curtain spray is piloted on with the cutter head to ensure water use is optimised and maintain comfort for the operators of the bolting rigs.

The spray bar was designed to be interchangeable to allow for protection on both sides of the miner and the ability to apply the curtain sprays to the off tube side of the miner regardless of the tube position in the mining sequence.

Approximate Cost

The integrated hungry board spray has a predicted life cycle of 4 years to be replaced at each overhaul at a cost of $3,568 per unit.

The following cost savings can be predicted: annually the fleet of 3 continuous miners use approximately 110 of 5-1 hydraulic hoses. At a cost of $2,095 per hose kit the total savings in materials are outline below:

$$110\ hose\ kits\ annually\ \times \frac{\$2095}{hose\ kit}$$

$$= \$230\ 450$$

Change out duration for a 5-1 hose kit is approximately 70 minutes. The cost savings related to lost production and labour are outlined below:

$$110\ hose\ kits\ annually \times \frac{70\ minutes}{hose\ change} \times \frac{1\ hour}{60\ minutes}$$

$$= 128.3\ hours\ lost\ production$$

$$Approximation\ of\ 10\ days\ Longwall\ Float$$

$$128.3\ hours\ labour\ \times \frac{\$60}{1\ hour}\ fitter\ labour$$

$$= \$7700\ in\ labour\ costs\ annually$$