Editor's Comment

Doing more with less

Marco Biffi
Honorary Editor

Please send your comments and opinions to info@mvssa.co.za

"Doing more with less" is the theme of the 2018 Annual Conference that will be held from the 31 May to 01 June 2018. Keeping in line with the theme, Council has decided to let the AGM coincide with the Conference - a first indeed for our Society. Effectively this implies that there will be less time to present technical papers and interact with colleagues and sponsors. Is this situation possibly demonstrative of the risk or even the consequence of wanting to do more with less? Does it mean that doing less implies foregoing quality or that we must strive to achieve more despite the reduction in resources?

In accordance with the "right here and now" pace at which our world is operating,this approach might be apt. However, those of us with receding grey hairlines and budding potbellies look at this "brave new world" with some apprehension.

The Mining Industry across the globe is adopting new paradigms, driven by resurgent industrial demands, seemingly determined by novel, if not strange, socio-political and socio-economic imperatives - very different from those with which we have been accustomed. The fear is that too many corners will be cut for the sake of doing less while losing sight of what is needed to ensure the health and safety of potentially exposed workers.

This is obviously not the place where to debate the reasons and merits of this situation. History, particularly in the last two hundred years has shown that new, novel, revolutionary and innovative does not necessarily mean wrong, unacceptable, inadequate nor disastrous. What we are seeing here is possibly yet another growth or developmental cycle: one of the numerous ones that have taken place since the Industrial Revolution.

However, it is apt to reflect briefly on the impact that these dynamic developments may have on our profession and its role within the Industry. It must be premised, and some will argue, that Ventilation Engineering in the context of mining in South Africa, is unique. The role of this profession is unique, the qualifications on which it is based are distinctive as is the level of expertise that professionals in this discipline are intended to attain. As we are well aware, these special requirements are linked to mining conditions peculiar to the majority of South African precious metal orebodies that are still mined by labour-intensive methods that in turn result the exposure of a large number of miners to potentially hazardous conditions - both in terms of safety and health.

The introduction of higher levels of mining mechanisation, currently touted by many mining operators in pursuit of higher levels of productivity (i.e. achieving more with less), inevitably results in the use of more diesel-power underground mainly forore loading. In some, less fortunate, operations this extends to the use of even more powerful (read "dirty") trucks - the luckier operations get to use conveyor belts. There are very few incentives at this stage to motivate a major switch over to cleaner power supply for mobile units underground. In fact, these cleaner technologies do not quite match the performance of their diesel-powered counterparts.

Therefore, even in scenarios where mechanisation will reduce the workforce considerably, the need to address the residual health and safety risks manageable by ventilation-system dependent controls, will still require the good old DEFC cure,i.e. Dilution, Extraction Filtration Cooling, unless and until a full understanding and application of the hierarchy of controls takes hold in the Industry.

The question therefore still remains: quo vadis ventilation officer? The term "ventilation" as opposed to "occupational hygiene" is stressed since the exposure of workers would always have to be assessed irrespective of the level of mechanisation and sophistication of the mining process. However, the engineering half of this equation, the one responsible for the control of conditions, will have to be "reinvented".

We should ask ourselves whether the employment of skilled individuals to perambulate all working places with a set of, sometimes outdated, instruments that provide somewhat accurate data (for example temperature or excavation cross-sectional areas for example) every ninety days, is conducive to a well-run and effective ventilation system, particularly when intending to use ventilation on demand tactics? How can manual monitoring of the ventilation and cooling system performance enhance power-saving strategies for these systems? It has been said before in this forum that the answer lies in real time monitoring of data across the mine, at a level of detail appropriate for the control functions and response times required.

You may well ask "What about the incumbents currently doing the "manual" monitoring?" The first part of the answer is a preamble: this change is going to be rapid but will not take place overnight. This must be a planned and managed change that is gradual and covers technology as well as the development of new skills integrated in the overall and over-arching design of the mines of the future. The next generation ventilation engineers will also have to be skilled technicians who will take charge of the monitoring and management systems that will control underground workplace conditions in real time. They will be responsible for the installation, calibration and upkeep of the monitoring systems while still being responsible for the planning and design of new systems and expansion of existing ones. The education and training required will have to be changed accordingly.

What is missing? It is an overall understanding and acceptance of this vision and the will to work towards this alternative by all players from management to mine designers and ventilation professionals alike. Doing more with less will be disastrous in all respects and will serve no purpose unless the "doing" is adequately planned, understood and supported by all concerned.

It is my hope that this may provide you some food for thought as we enter the holiday season and yet another new year.

Dust suppression on open pit drill rigs

S.A.J. Potgieter, Skorpion Zinc Mine, Namibia,
J.J.L. du Plessis, University of Pretoria, South Africa

ABSTRACT

Spotters and samplers working around surface drill rigs can be exposed to high dust concentrations. In this study it was found that individuals were exposed to as much as 14.2mg/m^3, which exceeds the Occupational Exposure Level of 10mg/m^3. The work on which this paper is based included an extensive literature study, as well as field investigations on a surface mine in Namibia. A number of additional dust suppression interventions were identified. These improvements, listed below, will assist in reducing dust concentrations around the drill rigs:

- Increase maintenance frequency on the shroud, sealing ring, suction pipes and filters of the drill rigs.
- Design and install new overlapping rubber belts on the shroud of the DM45.
- Install an air-blocking shelf on the inside perimeter of the shroud of the DM45.
- Install an airflow meter to ensure that the QC:QB ratio never drops below 3:1.
- Only allow wet drilling.
- Flush the dust collector system more regularly with compressed air to ensure that it does not become blocked.
- Introduce stricter supervision to ensure that the suction pipes are always connected to the shroud.
- Give drill rig operators more advanced training to ensure more effective drilling in order to reduce dust levels.

It can be concluded that the implementation of the recommended improvements in engineering controls, better maintenance practices and better operating practices will assist in preventing any potential respiratory diseases and the degradation of the surrounding environment.

INTRODUCTION

The mine studied uses drilling and blasting operations to break the rock. Loading and hauling then follows with a monthly production of 1.6Mt. The pit is currently 160m deep, 1200m long and 900m wide and will eventually reach a final depth of 310m. A bench height of 10m is being utilised.

The mine's target is to drill 147 holes per day, which equates to a total of 1613m per day. This target is achieved by employing the following drilling fleet:

- Three Atlas CopCo Roc-L8 with down-the-hole hammers.
- One DM45 drill rig with a rotary tricone drill bit.

Excessive amounts of dust in or around the pit were reported by the blasting, geology, surveying and maintenance crews that work next to the blocks being drilled. The drill spotters and grade control operators working in the vicinity of the drilling area are, however, the most susceptible to the dust exposure, leading to potential respiratory diseases.

Although the drill rigs have dust suppression systems in place, the correct utilisation and maintenance of these systems are often under-utilised due to production pressures.

An additional four drill rigs will arrive in the near future to the mine. The introduction of the new drill rigs will contribute to even higher dust levels in or around the open pit. To improve conditions around the drill rigs and reduce the potential exposure of workers it is important to determine the deficiencies of the dust suppression systems currently installed on the drill rigs. It is also important to determine the shortcomings in maintenance and operating procedures.

SUPPRESSION OF DRILLING DUST

If not properly controlled, drilling operations may expose drill operators, drill helpers/spotters, and grade control operators to large amounts of respirable dust. Controlling dust at the drill rigs can be achieved using a wet suppression system and/or a dry suppression system.

WET DRILLING DUST SUPPRESSION

The wet suppression system works by introducing water into the bailing air that is sent down the drill stem. The water then mixes with the dust and drill chippings at the bottom of the drill hole where the dust is liberated. This allows the dust particles and drill chippings to stick to each other, making them less airborne as they are bailed out of the drill collar. Other than dust suppression, the advantage of using water in percussion drilling is an improvement in the penetration rate of drilling (Cecala et al., 2012).

According to Page (1987) (in Cecala et al, 2012), tests have shown that wet drilling can reduce dust levels up to 96%. It is, however, critical that the drill operator ensure that the water flow rate entering the bailing air is correct. Cecala (2012) stated that the flow rate can range from 3.8 to 7.6 l/min depending on the type of drill rig, the geology and the moisture content of the rock being drilled. At some sites it was found that the dust suppression efficiency could be increased by increasing the water flow from 0.8 to 2.3 l/min. However, when 3.8 l/min was reached, operational problems were encountered. This was due to the drill chippings becoming too heavy to be removed by the bailing air; they started to plug the drill bit and bind the drill stem (Cecala et al, 2012). It is therefore required that the drill operator adjust the water flow rate until the maximum amount of dust is being suppressed without encountering operational problems with too much water.

There are, however, disadvantages to using water with rotary drilling. According to Cecala (Cecala et al., 2012), water can reduce the life of tricone roller bits by 50% or more. This deterioration of the drill bits can be prevented by using a water

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Compressed oxygen self-contained self-rescuers - *eliminating the risks of chemical oxygen SCSRs*

M. Kay, Ocenco Incorporated

ABSTRACT

This paper details the inherent risks associated with chemical oxygen self-contained self-rescuers (SCSR) used in South African underground mining applications, and how these risks are eliminated through the deployment of a newly developed belt-wearable, compressed oxygen SCSR.

THE NEED FOR NEW TECHNOLOGY

The annual SCSR auditing and testing by the CSIR continues to confirm the inherent risks associated with chemical oxygen SCSRs - the oxygen capacity of the device cannot be assessed, the devices are difficult to activate, and the devices are known to spontaneously self-ignite (Schreiber et al., 2014, 2015).

Chemical oxygen SCSRs must be protected from the ingress of water and water vapour to prevent the potassium superoxide oxygen generator (KO_2) from reacting and prematurely releasing oxygen, thus reducing the oxygen capacity of the device.

Manufacturers of chemical oxygen SCSRs have attempted to mitigate this risk by integrating colour-change indicators into the protective cases that detect the presence of moisture, but these have been determined to be too insensitive to be a reliable indicator of oxygen capacity (Schreiber & Kielblock. 2004).

The only method available to predict the oxygen capacity of chemical oxygen SCSRs is to conduct periodic leak tests on the protective cases. According to the 2014 CSIR annual report, 9.3% of the audited chemical oxygen SCSRs failed the leak test.

Further, the CSIR report states that "the element of risk introduced by excessive leakage cannot be underestimated or ignored and that the escape route layout and location of refuge bays should be based on actual SCSR performance characteristics."

The ingress of water vapour has the secondary effect of making it difficult to start the KO_2 reaction when the device is needed in an emergency. There are numerous reports of chemical oxygen SCSRs being difficult to impossible to activate, the Sago mine disaster in the United States being one of the more tragic examples in regards to loss of life, but also repeated incidents in South Africa where miners have required hospitalisation from gas and smoke inhalation after experiencing difficulties when donning chemical oxygen SCSRs.

The fundamental problem stems from the unstable nature of KO_2. The slow ingress of water vapour will cause the KO_2 to release oxygen and the granule to glaze over; compromising the KO_2's ability to generate oxygen when donned.

When KO_2 does activate and generate oxygen, it becomes semi-molten, fusing the granules and increasing the breathing resistance through the scrubber. This increase in breathing resistance is continual and can cause the miner to prematurely remove the SCSR. Increased resistance also increases the velocity of the gas through the scrubber. This increase in velocity reduces the oxygen generation and carbon dioxide removal while adding respiratory stress to the miner.

Most of the chemical oxygen SCSRs used in South Africa require the miner to fully exhale three to six times into the device in order to activate the KO_2 and generate oxygen flow. The obvious risks to this donning method are twofold. First, the miner is forced to repeatedly inhale potentially toxic mine air and exhale it into the SCSR. If he survives the donning sequence, he is left with an SCSR full of toxic gas that he will continue to rebreathe during his escape.

The second risk to this donning method is that the miner has no way to determine if the KO_2 is generating oxygen. If it is not generating oxygen and the miner begins his escape, the oxygen level of the breathing gas will drop, and the miner will become hypoxic and pass out.

Chemical oxygen SCSRs that are equipped with oxygen starters, either chlorate candles or small compressed oxygen cylinders, are no more reliable as these components are known to fail. In 2012, a US manufacturer of chemical oxygen SCSRs removed over 11,000 chemical oxygen SCSRs from underground service due to leakage of oxygen from starter cylinders. The starters were not equipped with indicators that would have notified the user that the starter cylinders were faulty. SCSRs that rely on chlorate candle starters have an increased risk of ignition due to the rapid generation of heat and oxygen that occurs when the candles are triggered. The US Navy has experienced ignition of chlorate candles used in chemical oxygen emergency escape breathing devices, and has replaced the chemical oxygen apparatus with a compressed oxygen escape device.

The most serious risk associated with chemical oxygen SCSRs is the risk of spontaneous ignition. The CSIR has reported several instances of chemical oxygen SCSR ignition, occurring both in mines and in the test laboratory (Schreiber et al., 2014, 2015). SANS 1737 includes a warning to keep chemical oxygen SCSRs away from excessive heat, electricity, and other potential sources of ignition. Manufactures of chemical oxygen SCSRs instruct users not to leave damaged or used SCSRs underground as they can react with water and coal and start a fire. Transportation of KO_2 by passenger aircraft is forbidden due to the fire risks it presents. SCSRs are designed to protect miners after a catastrophic event has occurred. A SCSR that spontaneously ignites now becomes the catastrophic event. A single SCSR that fails to provide respiratory protection results in a single casualty; a single SCSR that ignites spontaneously in a confined space may result in multiple casualties.

These risks are inherent to all SCSRs that utilise KO_2. The only

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Current knowledge of frictional ignitions by continuous miner cutter picks

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ABSTRACT

Frictional ignition by cutter picks from continuous miners has been a subject of great concern in the past few years due to the increasing occurrence of such incidents.

As part of the Coaltech Research Project, Safety around continuous Miners. CMSafety1 2013, a desk top study of the available literature on national and international knowledge of frictional ignitions from continuous miner picks was conducted to determine the current level of knowledge in the South African coal mining industry around frictional ignitions by continuous miner cutter picks.

Also carried out was a technical review which focused on finding out if the knowledge in the literature is known and/or applied in the industry.

Several mining companies, a pick company and continuous miner companies were visited, as well as a questionnaire send out to the mines to gather data in order to identify possible research gaps on the subject, and the technical feedback was combined with literature review findings.

Past work on frictional ignitions by coal cutting picks was reviewed, with reference to the factors that contribute to ignitions outlined. The research has also identified significant inputs that must be considered for risk assessment for frictional ignitions potential in a specific area.

INTRODUCTION

Frictional ignitions in coal mines occur when rock and metal rub against each other and the resulting heat ignites fuel, and are the main source of coal mine ignitions accounting for up to 70% of all ignitions.

The metal is the continuous miner pick and the rock generally being the sandstone roof or floor, sandstone inclusions in the coal or pyritic nodules, and the fuel is methane. This is a known problem in the South African coal industry, and extensive research and laboratory scale experiments have been conducted nationally and internationally and a great deal of information on the mechanism and parameters of frictional ignitions are known.

Incidents of this nature are an operational safety threat that may lead to major explosions. The seriousness of the methane ignition and the resulting methane and coal dust explosions are witnessed by the series of explosions in the coal mines worldwide.

There are three main types of friction that could generate sufficient heat to initiate a frictional ignition in the underground environment. These are pick on rock, metal on metal and rock on rock. The objective of this research will be to focus on the pick on rock friction.

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FRICTIONAL IGNITION MECHANISM

When using mechanical miners, the coal is broken from the solid through the action of the cutting picks on the cutting drum. The action of cutting also releases methane from the coal.

When a continuous miner cutter bit strikes rock, abrasion from the rock grinds down the rubbing surface of the bit, producing a glowing hot metal streak on the rock surface behind the bit. The metal streak is often hot enough to ignite methane, causing a frictional ignition. It has been shown that the semi-molten trail of rock and pick metal left behind the tool (not the shower of orange sparks usually associated with rock cutting) is the primary source of heat that is igniting methane.

The type of rock most likely to cause ignitions will have a quartz content of greater than 30%, and a particle size greater than 10µm and usually greater than 70µm and the characteristic that it retains its strength at temperatures of at least 1250°C.

COMMON PARAMETERS CONTRIBUTING TO FRICTIONAL IGNITION

Common contributing parameters to frictional ignitions are not new and are well documented.

Methane

Methane is released during coal cutting .The minimum ignition temperature of methane is reported to be around 650°C to 750°C, but this increases to over 1000°C as the size of igniter reduces. The time to initiate an explosion is around 0.3 seconds for 9.6% methane composition, increasing to 8 seconds at 12 to 14 mixtures. Due to the high ignition temperature of the methane, sparks alone do not usually possess an adequate combination of life time, temperature, and surface area to cause ignition.

Detecting methane gas in the working areas

Methane can only be detected by means of measuring instruments. In the working areas continuous miner machines are equipped with onboard methane detection equipment that is interlinked to the power supply of the continuous miner. The most common positioning of flammable gas monitors is on the front left (return ventilation) side of the boom, at about 2m behind the cutting drum. All continuous miners are designed with a slot for the monitors to be installed. Installation, design and calibration of the monitors is done by the third party monitor instrument company selected by the mining company or the Continuous Miner (CM) companies.

Diesel engine emission deterioration – *a preliminary study*

C.J. Pretorius, Council for Scientific and Industrial Research (CSIR), South Africa

ABSTRACT

The objective of this study was to find a parameter in diesel and oil analysis of underground mining vehicles that can be correlated with personal diesel particulate matter (DPM) exposure and used as part of an engine maintenance programme. A number of engines were monitored over a period of a few months. Diesel and oil samples were taken from selected engines and the personal DPM exposures of the operators were measured. Eight oil contaminants were chosen and compared with the DPM exposure results. It was found that as the oil contaminant concentrations increased, the DPM exposure of the machine operators increased. When remedial actions were taken on an engine during maintenance, the DPM exposure of the operator reduced. The preliminary study results show that the oil and diesel parameters can be used as an indicator of how the DPM emitted by the engine deteriorates (i.e. worsens) over time. This information can be used to enforce better maintenance regimes to reduce mine employee exposure to DPM.

INTRODUCTION

Diesel particulate matter (DPM) forms due to the uncontrolled combustion of fuel. Proper engine maintenance by qualified personnel has been shown to have a considerable impact on the control of DPM (Waytulonis, 1992a), among other available solutions.

Uncontrolled combustion is the result of, but not limited to, a few factors:

- Poor spray pattern caused by blocked injector tips (dirt, wear debris) or burnt injector tips from excessive combustion heat.
- A too-high cetane index, which causes combustion too close to the injector tips and not in the combustion chamber. This also causes damage to the injector tips.
- Filter blockages due to dirt or microbiological growth (Robinson, 2005).

Against this background, this study aimed to evaluate diesel and oil test results over a period of seven months to establish the resulting DPM values.

OBJECTIVE

The objective of this study was to find a parameter in diesel and oil analysis results that can be correlated with DPM exposure and used as part of an engine maintenance programme.

METHODOLOGY

At the start of the study, ten diesel powered engines were chosen for this project. Over time, some engines became unavailable over the full study period (e.g. breakdowns). In the end, two Tier 2 Load Haul Dump (LHD) vehicles were selected from two underground platinum mines. These engines were chosen because they had recently undergone a major service or had recently been refurbished. The original plan was to conduct this exercise over a period of 12 months. However, a delay caused by unplanned labour unrest in the platinum industry meant that this fieldwork was reduced to six months.

Once a month, personal DPM exposure measurements of the LHD operators of the selected engines were taken. The operators of the engines were fitted with a personal sampling train to measure DPM exposure for the duration of their shift. The sampling train consisted of a real-time DPM instrument (AirtecTM, FLIR, USA), size-selective cyclone (GS1, SKC, USA) with impactor and a three-piece cassette with a tissue-quartz filter inside the instrument.

The flow-rate was set at 1.7l/min. The filters were analysed with a Sunset DPM Analyser according to the NIOSH 5040 test method. The results obtained were for elemental carbon (EC), organic carbon (OC) and total carbon (TC).

Diesel and oil samples were taken from the LHD diesel tanks. The oil and diesel samples were taken in the middle of the shift when the engine had operated for a while and the oil had had a chance to circulate through the engine. The wear materials and contaminants were captured in the oil and detected during the analysis. Oil is usually replaced after a period of time and is representative of the cumulative condition of the engine.

Samples were also taken intermittently over the study period from the oil and diesel bays from which the machine operators would refuel or replenish the engines. At the start of each shift, the operator would fill the engine tank with diesel. The diesel samples that were taken once a month would largely be representative of the condition of the diesel on that day and would have minimal representation of the historical, cumulative condition.

The oil and diesel samples were sent to Wearcheck Africa for analysis. Wearcheck Africa is an ISO 17025-accredited laboratory and carries out diagnostic interpretation of analytical parameters of diesel and oil. The diesel samples were tested for conformance with the SANS 342:2006 standard for diesel.

The oil analysis parameters that were considered for the monthly evaluation are presented in Table 1. The source or cause of the parameter is specified in the table.

The diesel properties that were considered during this study are set out in Table 2. These properties are required to conform to the SANS 342:2006 national standard for diesel. If any of these properties differs from the specification, there could be an increase in DPM in the exhaust emissions.

At the start of the study, both of the study mines used 500ppm

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Fatigue knowledge -

a new lever in safety management

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ABSTRACT

The purpose of the paper is to give an introduction to the concept of fatigue and the causes thereof in the mining industry. By knowing the fundamental role it plays together with its dynamics can positively contribute to a mine's safety management system. The difference between physical and psychological fatigue will be addressed with possible range of causes that could trigger fatigue. There are two main sources of fatigue - firstly, work-related fatigue which is associated with activities at the workplace and secondly non-work-related fatigue. The shared responsibility between the employer and employee was also discussed as it involves factors that occur both in and outside the workplace. Employers have the responsibility to manage fatigue through using a risk management approach. Employees have the responsibility to ensure they get enough sleep, take sufficient and regular nutrition, health and physical fitness and come to work fresh and alert. The impact of the implementation of fatigue management plan and procedures has the potential to eliminate employee fatigue or its causes, reduce the likelihood of fatigue occurring in the workplace, and counteract the effects of fatigue when it occurs. Factors considered when implementing a fatigue management system includes, extended hours of work, shift work, time of day and work design.

Fatigue is one of the major role players (either causal or contributory) when it comes to causes of fatalities in the mining industry. Our main challenge in identifying whether fatigue played a role is the fact that it can't be tested in post-mortems like drug or alcohol abuse. It is also not an issue to look at as yet another aspect for reasoning failures, rather an aspect worth understanding and getting an organisation sensitive to managing it properly to benefit both organisational as well as employee needs.

INTRODUCTION TO FATIGUE

Fatigue is a feeling of weariness, tiredness, or lack of energy that does not go away when a person rests. People may feel fatigued - in body (physical fatigue) or mind (psychological fatigue). With physical fatigue, the muscles cannot do things as easily as it used to. With psychological fatigue, it may be difficult to concentrate for as long as a person is used to. In severe cases, a person might not feel like getting out of bed in the morning and doing his/her regular daily activities. The question could be asked then what the causes are for being tired all the time. Most of the time, fatigue can be traced to one or more of a person's habits or routines. Fatigue can be a normal and important response to physical exertion, poor eating habits, emotional stress, boredom, or lack of sleep. In some cases, however, fatigue is a symptom of an underlying medical condition that requires medical treatment. When fatigue is not relieved by enough sleep, good nutrition, or a low-stress environment, it should be evaluated by a medical practitioner.[2]

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SYMPTOMS/SIGNS OF FATIGUE

According to Better Health Channel[2] fatigue can cause a vast range of other physical, mental and emotional symptoms including:

- Small errors, lapses and slips (dropping tools, picking up the wrong item, etc.); Chronic tiredness or sleepiness (not feeling refreshed after sleep - waking tired);
- Difficulty keeping your eyes open, head nodding and falling asleep at work;
- Drowsy relaxed feeling (yawning or visible drowsiness);
- Micro sleeps - falling asleep for less than a second to a few seconds, and being unaware that you have done so (usually due to sleep loss);
- Headache or dizziness;
- Sore or aching muscles or alternatively muscle weakness;
- Slowed reflexes and responses;
- Impaired decision-making and judgement;
- Moodiness, such as irritability;
- Impaired hand-to-eye coordination or blurry vision;
- Appetite loss or reduced immune system function;
- Short-term memory problems, poor concentration or hallucinations;
- Reduced ability to pay attention to the situation at hand;
- Low motivation.

A RANGE OF CAUSES OF FATIGUE

The Better Health Channel[2] also distinguished between wide range of causes that can trigger fatigue include:

- **Medical causes** - unrelenting exhaustion may be a sign of an underlying illness, such as a thyroid disorder, heart disease or diabetes.
- **Lifestyle related causes** - feelings of fatigue often have an obvious cause, such as sleep deprivation, overwork or unhealthy habits.
- **Workplace related cause**s - fatigue could be caused as a result of shift work, poor workplace conditions and work related stress.
- **Psychological causes** - fatigue is a common symptom of mental health problems, such as depression and grief, and may be accompanied by other signs and symptoms, including irritability and lack of motivation.

The approach followed to conduct an "Exposure allocation methodology comparison study" *on Respirable Quartz Concentration for quarterly leading indicator reporting purposes*

S. Wheeler[1], K. Dekker[2]
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ABSTRACT

This paper discusses the approach that was followed to evaluate and compare the results from 5 different dose calculation methodologies to calculate and allocate employees' Respirable Quartz Concentration (RQC) exposure, when reporting "Quarterly Leading Indicators" to the Department of Mineral Resources (DMR).

The need for this project originated as it seemed that there is currently more than one method to calculate (and subsequently allocate) employees' RQC exposure when reporting "Quarterly Leading Indicators" to the DMR.

1. INTRODUCTION

1.1. Purpose

The purpose of the study is to conduct an "Exposure allocation/calculation methodology comparison study" for Respirable Quartz Concentration (RQC).

The need for this project originates as it seems that there is currently more than one method to calculate (and subsequently allocate) employees' RQC exposure when reporting "Quarterly Leading Indicators" to the Department of Mineral Resources (DMR).

The aim of this project will be to compare the results obtained from different exposure calculation and allocation methods.

2. PROJECT METHODOLOGY

2.1. Project Site

One of the deep underground gold mines situated in the Witwatersrand (South Africa) area was selected as the project mine.

The personal exposure to RQC data collected during 2014 was utilised for this study.

Exactly the same personal dust exposure data was utilised in each of the methods discussed in this report.

2.2. Method 1 (Method Currently Utilised by the Mine)

2.2.1. Exposure data

The exposure data of the current quarter was utilised to calculate the exposure category (as per the method specified in the South African Mines Occupational Hygiene Programme (SAMOHP) Code Book) for each Homogeneous Exposure Group (HEG) for the specific quarter.

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2.2.2. Statistical indicator

The exposure category for the HEG calculated by means of the 90th percentile value of all samples collected during the quarter within the HEG.

2.2.3. Quartz analysis utilised

Allocate the average silica content, of all samples analysed during the previous year, as the only average silica content for the current quarter.

2.2.4. RQC exposure allocation

All employees within the HEG are allocated the same exposure category as an indication of the exposure dose received for the specific quarter.

2.3. Method 2

2.3.1. Exposure data

The exposure data of the current quarter was utilised to calculate the exposure category (as per the method specified in the South African Mines Occupational Hygiene Programme (SAMOHP) Code Book) for each Homogeneous Exposure Group (HEG) for the specific quarter.

2.3.2. Statistical indicator

The exposure category for the HEG calculated by means of the 90th percentile value of all samples collected during the quarter within the HEG.

2.3.3. Quartz analysis utilised

Allocate the actual analysis results for each sample submitted for analysis during the quarter.

Samples analysed and found to be "Below Detection Limit" (BDL) are allocated a silica content equal to the average of all other samples analysed during the quarter for the specific HEG, as indicated in the table below:

HEG	Average Silica Content (%) of all Samples Analysed during the Quarter				
	Q1	Q2	Q3	Q4	2014
Stoping	28.8	26.9	23.4	33.9	28.7
Development	24.7	20.3	23.3	23.7	23.2
Tramming	19.3	25.8	21.1	24.2	22.3
Shaft & Services	19.8	26.0	21.5	24.4	22.7
Roving UG	23.0	20.8	22.9	26.3	23.0
Roving Surface	16.3	25.9	28.7	14.3	20.3

2.3.4. RQC exposure allocation

All employees within the HEG are allocated the same exposure category as an indication of the RQC exposure received for the specific quarter.

Block cave mine ventilation optimisation techniques

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ABSTRACT

Block cave mining operations are widely used for the extraction of steep to vertical orebodies typically found in diamond and base metal deposits. Block caving permits large volumes of ore to be extracted relatively cheaply, increasing production and making lower grade ore bodies economical to mine. These mines are constructed in two main phases, i.e. capital development phase and full production phase.

When considering ventilation engineering planning, it is essential that the mine layout and plan are correctly understood for both phases. Depending on mining schedule and design, ventilation engineering challenges include airflow profiles that typically have peaks during capital development when the apex and/or undercut, extraction, haulage and ore transport levels require many development ends to be ventilated simultaneously.

Various mines were investigated for similarities and differences in mining layout, ore handling and ventilation engineering. The paper summarises ventilation and cooling techniques that were identified that can be employed to optimise block cave mines to ensure fit-for-purpose mine ventilation designs.

1. INTRODUCTION

Block caving is generally considered when open pit mines become exhausted and extension of the mining operations is required. Block caving is a well-established underground hard rock mining method that can be utilised for near-vertical orebodies.

A block cave is established a few hundred meters below the open pit operation and progressively collapses under its own weight and gravity (Figure 1).

Block caving ensures extraction of large volumes of ore at a

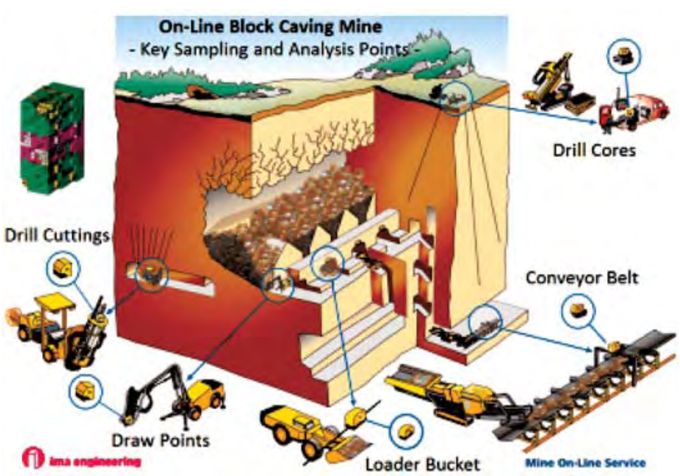

Figure 1. Block cave mining method

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Figure 2. Planned and operating block cave mines

reasonable cost and with the increased production rates; low-grade orebodies can now be more economical to mine.

This mining method is more efficient than any other underground mining method and is being considered more frequently worldwide.

Figure 2 shows major operating and planned block cave mines across the globe (some information from Hem and Caldwell (2012)).

The objective of this paper is to demonstrate the role that the ventilation fraternity plays in mine planning when employing optimisation techniques that will lead to a LEAN, fit-for-purpose mine design. The LEAN business principle relates to practices that aim to create more value with fewer resources just-in-time.

2. BLOCK CAVING INFRASTRUCTURE

Block caving initially involves a significant amount of capital development as the selected production footprint needs to be accessed from shafts and/or declines from surface.

Thereafter horizontal development starts on a number of levels that generally include an apex level, undercut level, production/extraction level, ore handling/haulage level and ventilation levels (Calizaya and Mutama 2004).

3. BLOCK CAVING PROCESS

During the capital development phase, the apex level is mainly utilised for inspection to ensure the 'w' shaped funnels between the undercut and apex level are connected (Figure 3).

On the undercut level parallel drifts/crosscuts are developed where drilling and blasting takes place to destress the cave. On the extraction level parallel crosscuts are developed from which draw-points and draw-bells are drilled and blasted. Another level is typically developed below the extraction level for ore transport, water pumping and return-ventilation (Duckworth et al. 2005). Haulage level and ventilation level airways are initially utilised to ensure that through-ventilation between the levels is achieved during the capital development phase.

During the capital development phase first production tons will be mined and a slow production ramp-up rate will be achieved. It is however only after the above horizontal infrastructure is

Operational advantages of mobile refrigeration

using a closed loop heat rejection configuration

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[1]M-Tech Industrial (Pty) Ltd, [2]North-West University

ABSTRACT

The operational advantages of localised cooling, in particular moving the cooling source as close as possible to the area where cooling is required, has been investigated by different authors over a number of years. A notable advantage is the energy efficiency potential associated with cooling locally, mainly due to the savings obtained from a reduction in cooling water and the reduced dewatering pumping power of water back to surface. The challenges with supplying water from the cooling source to the remote areas where the cooling is required led to the development of mobile refrigeration units capable of providing localised cooling. The developed mobile refrigeration air cooling unit (ACU) alleviates some of these problems by increasing the amount of cooling that can be done per litre of water available. These result in more effective and energy efficient cooling, but these units do however still require cooling water to operate. This paper looks into the possible operational advantages, including energy efficiency and reliability, when the condenser circuit of the ACU is not connected to the main cooling water supply, but rather connected in a closed loop heat rejection configuration with the return airway (RAW).

1. INTRODUCTION

Engineers working in the mining industry in South Africa are continuously looking for ways to improve the mining operations with regards to energy usage, reliability, safety and cost. In labour intensive mining operations it is impossible to improve the overall mine performance without looking at the performance of the ventilation and cooling systems. Special emphasis is placed on the energy efficiency of the ventilation and cooling systems as the margins of profitability of mines are under pressure as the mining distance increases both vertically and horizontally.

Ramsden et al. (2001) states that several South African gold mines are examining the feasibility of extending workings to below 4000m. "Since 2010, the AngloGold Ashanti Technology & Innovation Consortium (ATIC), established by AngloGold Ashanti, has been looking for ways to leverage established technology in new ways, in an effort to not only extract additional gold from current depths of around 4000m, but also to realise its long-term vision to reach depths of 5000m and beyond." (AngloGold Ashanti, 2013). The increased travel distance for air to get from the shaft inlet to the working areas means larger heat gains and therefore more cooling required. This in turn means that the cost to mine in remote areas increases due to the increase in cooling demand and the increase in energy usage to supply cooling water to the areas and return it back to surface. The costs associated with the installation of infrastructure to enable mining in remote areas also make it less attractive to mine in these areas.

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2. COOLING METHODS

Infrastructure for the cooling of remote underground working areas usually consists of a cooling source (usually a fridge plant or ice plant), a chilled water reticulation system (consisting of storage dams, pipes, pumps, etc.), bulk air coolers (BACs) and localised cooling units.

2.1. Localised cooling units

Localised cooling units, as the name indicates, are used to cool air near the working areas. These units usually have a lower cooling capacity than larger BACs and can be moved when cooling is required elsewhere as the mining progresses.

2.1.1. Conventional cooling cars

Cooling cars (CC) are air-to-water heat exchangers mounted in a chassis on rolling stock, which enables them to be moved and installed in different areas of the mine. These units are installed near the working areas and are small in size to ensure that the units can be moved with relative ease. CCs have an inlet and outlet water connection to which the chilled water supply and return piping can be connected. A fan is mounted onto the CC to force air over the finned tube cooling coil (see Figure 2-1).

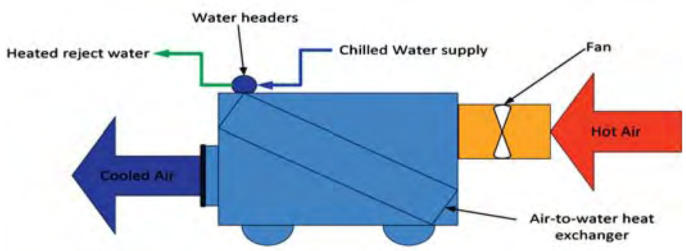

Figure 2-1. Illustration of a cooling car layout indicating water and air flow paths

The cooling capacity of these units are directly dependent on four inputs namely the air mass flow rate, the water mass flow rate, air temperature (dry-bulb and wet-bulb) and the water temperature.

2.1.2. Mobile refrigeration units

The Air Cooling Unit (ACU) is a mobile refrigeration unit, which consists of a vapour compression system in a chassis mounted on rolling stock, which means that the cooling source can be moved closer to the working areas. The feasibility and energy efficiency of these cooling units was first investigated by van Eldik (2007).

The ACU MKI was developed capable of producing approximately 100 kW of cooling.

The unit was deemed a more energy efficient alternative to using CCs because the unit could utilise less water, which greatly reduces the total electrical power consumption to cool deep level mines.

Ventilation of underground coal mines - *A Computational Fluid Dynamics study*

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ABSTRACT

The auxiliary ventilation systems used to ventilate the development headings has conventionally been studied by conducting experiments. Since the efficiency of any auxiliary ventilation system is dependent on a number of system variables, conducting such experiments on a large scale become a challenging exercise. With the advancement in computer systems and numerical codes, an alternate solution becoming popular in the mining industry is the use of Computational Fluid Dynamics (CFD). Although a number of researchers are using such software in the mining industry, the accuracy of the results is still questioned by the conservatives. This paper outlines not only the steps to be followed for conducting a CFD study in general, but also provides the results of three validation studies relating to auxiliary ventilation. This was done to emphasise how CFD can be used with confidence to study ventilation in underground mines. The work presented in this paper is part of a Ph.D. research study in the School of Mining Engineering at the University of the Witwatersrand.

1. INTRODUCTION

Mine ventilation systems have been designed and installed almost since the beginning of mining, and ventilation is a well-studied subject. A number of computerised mine ventilation network analysis software packages are available to design the main ventilation circuit. However, the ventilation of the blind headings, which is carried out using auxiliary ventilation equipment is studied and planned using experiments/experience and CFD analysis.

The efficiency of an auxiliary ventilation system is largely affected by the associated system variables (Suglo and Frimpong, 2002). The study of these system variables such as the dimensions of the headings, orientation and capacity of the auxiliary equipment, and velocity of air in the last through road (LTR) requires a large number of experiments. However, to carry out a large number of experiments in a mine has always been an expensive exercise. With the advancement in the field of computer science and numerical modelling, powerful computers and numerical software are available which can be used to study auxiliary ventilation and achieve extensive solutions. Due to these reasons, the need to use CFD is an important step forward.

The relationship between the experimental studies and numerical models has always been dependent on the validation of the numerical results with experiments. Therefore, a primary requirement/limitation of a CFD study is the validation of the numerical model. Once validated these CFD models can be used to examine the different auxiliary ventilation configurations and enable the practitioner to predict, visualise and optimise the ventilation in headings.

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This paper aims to highlight the key steps involved to solve a ventilation problem in an empty heading using the ANSYS Fluent CFD package. Furthermore, the suitability of ANSYS Fluent k-e realisable CFD model for studying ventilation of an empty heading has been shown by conducting a comparison of three experimental and numerical studies.

2. KEY STEPS OF CFD

CFD is one of the branches of fluid mechanics. It started in the early 1970s and employed physics, numerical mathematics and computer sciences to simulate fluid flows. It has become a powerful tool in almost every branch of fluid dynamics and engineering (Ren and Balusu, 2010). CFD has been described (Anderson, 1995) as "the art of replacing the partial derivatives in the fluid motion equations with discretised algebraic form". The CFD solvers are designed to solve a set of Partial Differential Equations (PDEs) defining the flow fields of the problem. These PDEs (governing equations) as shown in Figure 1 are derived from the following three fundamental principles of physics which rule all the aspects of fluid flows (Anderson, 1995).

- Conservation of Mass
- Newton's Second Law of Motion
- Conservation of Energy

The governing equations are coupled equations, which are non-linear and are therefore, very difficult to solve analytically, necessitating the use of numerical methods. The system of equations is converted into algebraic equations which are subsequently solved numerically at discrete points in the time and or space, using different explicit and implicit numerical techniques. CFD can be used to solve fluid dynamics problems in both two and three dimensions, producing illustrative results, which helps the user to have an increased understanding of the problem.

The three steps to solve any fluid dynamics problem are (Anderson, 1995):

- Visualising the problem and defining the quantities that are required to be measured.
- Designing a mathematical model includes the selection of the governing equation/equations, and the initial and boundary conditions.
- Use numerical techniques to solve the fluid problems, which involve discretisation of the governing equations into algebraic forms to be solved at discrete locations.

3. CONCEPTUAL FRAMEWORK OF CFD STUDY

3.1 Pre-processing

It involves the creation and discretisation of the solution domain,

Editor's Comment

Quo Vadis?

Marco Biffi
Pr. Eng.
Honorary Editor

Please send your comments and opinions to info@mvssa.co.za

No, this is not the repetition of an old editorial – although the very same question has been asked many times in the pages of this Journal.

Today, irrespective of good intentions, the aspiration towards achieving zero harm, a major driving force within our Industry and for which we have been tasked, may remain just that if the support we provide and the role we can play is not recognised by our Industry's leadership.

So, what can we offer, particularly considering the current uncertain economic and social climate and how can we meet these "new" challenges?

The MVSSA has been pro-actively engaged during the last several years in restructuring the educational framework of this profession, together with the QCTO, MQA and University of the Witwatersrand in a self-funded effort aimed at providing correctly graded qualifications that are now registered on the National Qualification Framework (NQF) and the Higher Education Qualification Framework (HEQF). Soon these will replace the old Chamber of Mines certification system.

The question is whether this new direction will prove to be adequate for what are new demands of the new world around us.

Should the answer be left until the publication of findings from the current SIMRAC research on the duties of 12.1 appointees to be released before the end of this year?

To add to the anticipation, let us throw in the mix the attributes and skills that would be required broadly by young and modern ventilation engineers. A list of such attributes is offered below.

This is based on an article by the esteemed editor of a sister association, Mr Chris Reay, former Chairman of the communications working committee of SAIMEchE, who offered a similar list for young mechanical engineers in the March 2017 issue of that Institute's journal.

The list below has been reworked and rearranged based on a subjective opinion of our professional role within the mining industry.

1. Adequate technical qualifications, knowledge and experience.

These are all complementary and of fundamental importance. The intent of having recognised and registered qualifications replacing the Chamber of Mines certification system is aimed primarily at providing a formally recognised set of qualifications.

However, there are no discounts nor short-cuts to becoming knowledgeable and experienced: the one "feeds" on the other to "grow" the effectiveness of the incumbent.

Young professionals in this discipline must understand that experience (time), effort and sacrifices are essential in becoming credibly successful at this game.

2. Effective communication and inter-personal skills.

This might be counterintuitive. After all, this is an engineering discipline.

Let us remind ourselves that the mine ventilation discipline concerns itself with making the working environment safe and healthy for employees.

Until full automation of mines comes about, the employees are our customers and their well-being in the working environment is our raison d'être.

It is therefore important that mine ventilation professionals can understand and communicate accurately and effectively with all "clients".

The leadership and management of mine operations are important stakeholders as they are ultimately responsible and accountable for health, safety and production.

Good technical communication is at the base of a shared understanding of the issues with which this discipline is tasked for the good of all.

Resolving mine ventilation issues, getting new projects (both big but particularly "small" ones) off the ground, invariably requires the dedication of resources for which motivation, underpinned by proper understanding, is essential.

It is therefore important that the ventilation professional masters the requisite communication skills to inform and convince varied audiences of intentions, planned actions and consequences that form part of such initiatives. Adequate presentation (graphical) skills should complement this ability where required.

3. IT skills.

Although not taught formally (something that the Society may want to address in due time), the use of these skills has become essential in modern mining.

First and foremost is an intimate and extensive knowledge of the ventilation software simulation packages available in the Industry. With this goes the development of analytical skills, honed by experience, that prevent the occurrence of the "garbage-in-garbage-out syndrome": Glib acceptance of results from software outputs is a sure recipe for disaster.

The ability to interpret and manage database contents and transform these into intelligible and clear information suitable for further analyses, reports, presentations and discussions, is an important and requisite complementary skill.

The ability to work with AutoCAD packages may also be a requirement on certain operations for producing standardised and integrated layouts for ventilation control and construction work.

4. Project management.

Although projects are managed by qualified project managers, ventilation engineers would benefit from a basic but formal knowledge of project management.

Again the Education Sub-committee of the Society may want to note this requirement. To be able to participate as a functional and knowledgeable member of a project team should be deemed a requisite skill for aspiring ventilation engineers.

More importantly, the ventilation professional is expected to manage projects within the department as a leader of a sub-design study team focussing on ventilation systems.

Associated with this is the ability to conduct objective technical tests and investigations when considering the introduction of new methodologies and equipment (change management).

This skill is complemented by the commensurate ability to present results and recommendations in well-structured technical reports (point 2 above refers once more).

5. Professional licence to operate.

Chris Reay refers to this as the "mark of a professional" who is at the top of the game.

It is a "standard recognised by the government, clients and companies" that "assures the public" that the professional can perform "Engineering" work to the requisite level of performance.

Although not (yet) required by the DMR, a similar prerequisite may be deduced from the wording of existing regulatory requirements. These define Section 12.1 appointees as holders of the CoM Certificate, a clear pre-requisite for the employment of any such incumbent.

The reader should note that the MVSSA is progressing towards registration with the MQA as a Professional Organization and is consulting with the DMR to make professional registration with the MVSSA equivalent to a requisite licence to operate in the ventilation discipline within the SA Mining Industry.

Closing the gap between mine ventilation/cooling planning and implementation

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ABSTRACT

This paper deals with identifying and mitigating common risks related to planning and implementing mine ventilation and cooling systems.

The paper identifies a number of common pitfalls that take place in the transition from planning to implementation stages such as incorrect use of planning documents, lack of continuity of design team during implementation stage, inadequate performance testing of equipment and lack of adequate update Life-of-mine planning studies when there are changes to the mine design criteria.

Suggestions are given to close the gap between planning and implementation.

1. INTRODUCTION

Deep hot mines often require a substantial investment in ventilation and cooling infrastructure in order to dilute contaminants and provide conditions that are conducive to the health, safety and productivity of the underground workers.

For illustrative purposes refer the typical mine ventilation and cooling system shown in Figure 1. This example includes bulk air coolers (BAC) on surface at the intake shafts, main fan stations on surface at the upcast shafts and an underground booster fan station. Common contaminants in a typical mine include blast fumes, diesel fumes, flammable gases, dust, heat and humidity.

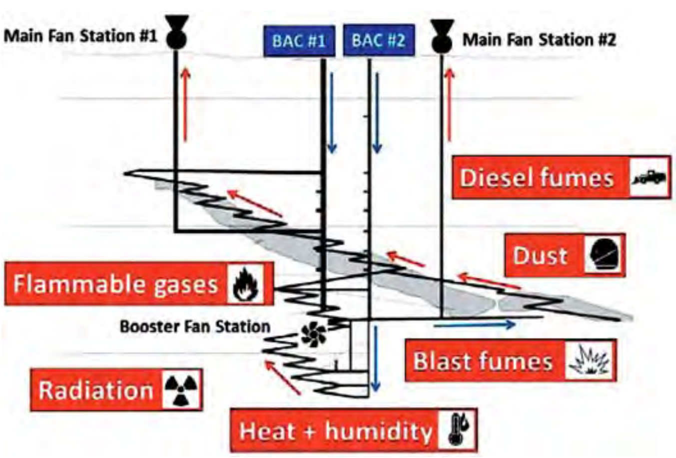

Figure 1. Typical mine ventilation and cooling system in a deep hot mine

The design of a mine ventilation/cooling system requires careful planning by the mine team in order to determine an appropriate design that will satisfy the short, medium and long-term requirements of the mine. However, in many cases, serious Errors-and-Omissions occur during the transition from planning to implementation stages. These errors can result in cost over-runs, delays in project completion and higher operating costs. This paper addresses the common pitfalls and gives suggestions regarding possible processes that can be used to close the gap between mine ventilation/cooling planning and implementation stages.

However even after successful implementation of the mine ventilation/cooling system there is still an inherent risk due to possible future unforeseen changes to the original mine design. This paper highlights this issue and gives suggestions on methods to deal with this risk during the project planning stages. The content of this paper is based on more than 20 years of personal experience by the author in this field.

2. SHOOTING A MOVING TARGET - CHALLENGES IN THE PLANNING STAGE

Much of the permanent ventilation/cooling infrastructure such as shafts/raises, main fan stations and refrigeration plants must be put in place from the onset of the project. The main fan stations and refrigeration plant are generally required to operate continuously with minimum shut-down periods.

Therefore, once installed, it is often impractical or too expensive to make any significant changes to this infrastructure. This constraint introduces an inherent risk should there be any unforeseen major changes to the original planning parameters such as production rate, size of diesel fleet, mine layout and depth of mining. The level of risk will depend on the likelihood and consequence of these possible changes.

By nature, mining involves a relatively high degree of uncertainty due to limited available knowledge of the orebody, geology, ore grades, rock mechanics and location of fault zones. For this reason, mining operations generally require an ongoing exploration program with drilling from surface and/or underground. Therefore, there is a high likelihood of future changes to the mine design during the life-of-mine.

In many cases, the changes to the mine design will be relatively small with minimum impact on the ventilation/cooling system. However, in some cases the impact can be severe. As an example, the discovery of previously unknown barren zone or faulted zone, that is either sub-economic or too risky to mine through, may cut-off the planned return ventilation circuit from the mining production zone located below this zone. The consequences to the mining operation can be severe, impacting productivity and air quality target over many years until the ventilation system can be remedied.

Original paper presented at the 2017 MVSSA Conference

Improving silica dust sampling techniques at South Deep Gold Mine
to assist in eliminating silicosis

L. Negondeni, South Deep

ABSTRACT

The inhalation of and exposure to Silica dust is a huge concern at Gold Fields, especially since mine workers continue to develop silicosis every year. The presently accepted method of analysis for determining silica exposures can only claim accuracy levels of between 60-80%. Personnel at South Deep are mindful of these tolerance levels and have instituted many checks and balances to reduce these variances and to attain a high degree of consistency in the sampling programme. This paper describes a number of steps that have been introduced into the sampling strategy to bring the ultimate goal of 100% reliable data closer.

1. INTRODUCTION

In South Deep's quest for "Zero Harm" the prevention of dust exposures and silicosis is now of paramount importance to all personnel at South Deep Gold Mine.

South Deep Gold Mine is a subsidiary of Gold Fields Limited. and situated approximately 40km South West of Johannesburg in the municipal area of Westonaria.

South Deep has always strived to be a leader in innovative thinking when dealing with issues of health and safety of its employees and stakeholders.

2. SILICA DUST

Silica dust is comprised of tiny particles of alpha quartz that are invisible to the naked eye, therefore visual identification of dust is not an appropriate measuring tool for determining silica exposures.

Currently, personal dust sampling by applying the MDHS 14/3 method in conjunction with laboratory analysis is the only internationally accepted way of accurately and consistently determining silica dust contents in an atmosphere. Even though this is an internationally accredited way to conduct sampling of atmospheres for the purpose of apportioning personal dust exposure levels to employees, this method can only claim accuracy levels of between 60-80%.

Over the past 5 years Gold Fields has never stopped questioning our silica dust data obtained from the sampling programme. This inquisitive nature has enabled us at South Deep to implement initiatives to improve our measuring techniques. The following fundamental discoveries and changes to our sampling strategy have enabled us to get a few steps closer to the ultimate goal of 100% reliable data:

1. Silver membrane filters
2. Laboratory analysis
3. HEG Classifications
4. Gravimetric sampling pumps
5. Mathematical calculations
6. Micro-balance (weighing scale)
7. Sampling cassettes
8. Cassette shrink seals
9. Dedicated personnel
10. Employee communication
11. Weighing scale / micro balance validation
12. Silica dust analysis
13. External auditing.

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3. SILVER MEMBRANE FILTERS

South Deep moved from using Mixed Cellulose Esters (MCE) membrane filters to using Silver Membrane filters, this was done after intensive research and consultation with industry experts. Research showed that MCE membrane filters tend to lose bits of fibre from the filter matter, ultimately reducing the mass of the filter, this mass loss can then be incorrectly interpreted as lower dust mass on the filter. This in turn can then influence the determination of the silica quartz percentages and potentially the accuracy of dose allocation to employees.

a) Mixed Cellulose Esters (MCE) *b) Silver Membrane Filters*

Figure 1. Comparison of filter types

The advantages of using silver filters are:

i. It does not lose filter fibres

ii. It is not affected by moisture/humidity so therefore no acclimatisation period is needed before weighing of the filter. Hence, an improvement in the reporting time of silica dust doses and earlier detections of over exposures, thus enabling investigations to be conducted much sooner after the event.

iii. It is more stable – less susceptible to heat and humidity changes.

Trackless Mining Machinery:

Is it Noise Induced Hearing Loss (NIHL) or Nerve Injury (NI)?

I. Sibisi & M. Barnard
Black Rock Mine Operations, South Africa

ABSTRACT

Going to the future, mining is mostly likely to be based on trackless machinery; this will be done in a bid to reduce the number of employee occupational health injuries, fatalities and hence maybe increase production.

In most first world countries, this practice has been put in place and more and more machinery is introduced underground, this includes remotely controlled robotics. This migration and technology advancement will not only come at a cost but also some occupational hygiene and ventilation challenges associated with mechanised mining.

Ventilation requirements will be increased significantly to reduce exposure to harmful gases, vapours and particulates to acceptable limits. The other challenge is the noise pressures emitted by these machines. Although the workforce directly working at the face will be reduced, it will still remain a concern for the nearby employees who will be exposed to such noises. Even in remotely controlled operations, there will still be a need for human beings to perform other duties where machines cannot reach.

Machines do break down and will need to be fixed or be sent to the workshop for repairs and maintenance, during which process there will be an interface between man and machinery.

The Compensation for Occupational Injuries and Disease Act (COIDA) and the Department of Minerals Resources (DMR) will always require mines (employers) to investigate every possible noise induced hearing loss in detail. Employees move from mine to mine thus making it difficult to track to the core the actual source or cause of the hearing loss. In more cases than not, most employees are found to have a hearing problem in one of the ears, which then begs the question "is it noise induced hearing loss or a nerve injury"? It is for this reason that at Black Rock Mine Operations a study was conducted to establish the effect of trackless machinery to the operator as well as the bystander or someone working in the vicinity of such machinery.

1. INTRODUCTION AND BACKGROUND

Noise Induced Hearing Loss (NIHL) is a preventable yet irreversible state in which an individual gradually loses their hearing ability. This may be caused by many factors, amongst others being exposed to high sources of noise for prolonged periods of time.

One person may hear a sound but the other people in the vicinity may not hear the sound. Such noises occur within the ear without the outside noises. The possible causes of noises in the ears without an outside sound source include middle, inner ear or eardrum damage, ear tumour, excessive earwax, or regular exposure to incredibly loud sounds. Hearing loss or taking certain medications can also lead to tinnitus, the medical term for ear noises.

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People with tinnitus hear varying types of noises, such as ringing, whistling, buzzing or roaring. Some people experience tinnitus in a single ear, while others hear noises in both ears. The older we grow the higher the chance to develop tinnitus.

There are two types of tinnitus namely subjective and rare. In both cases, the victim will hear noises in his/her ear. Subjective tinnitus is a common type of tinnitus in which a person is the only one who can hear certain noises in his ears.

A rare type of tinnitus is objective tinnitus, in which a person may hear a noticeable noise in his ears, particularly a noticeable pulsing sound related to his heartbeat, that others can hear as well. Objective tinnitus typically results from the presence of abnormal blood vessels in and around the ears.

People who frequently listen to loud music often experience temporary tinnitus. Mine workers who use noisy, heavy equipment are also prone to developing the condition. Moreover, a link exists between tinnitus and stress, anxiety and depression.

Medications that can lead to tinnitus include anti-malaria drugs, antibiotics such as erythromycin, diuretic medications, large doses of aspirin and certain cancer drugs.

Earache affects one or both ears and is mostly caused by an ear infection, injury, irritation, pressure changes and earwax accumulation.

Use of cotton swabs, water in the ear, sore throat, sinus infection and a foreign object in the ear are also possible causes. Some people experience earaches due to referred pain, which is pain that occurs in other regions of the body aside from the infected or injured area.

Earaches can be constant or intermittent, and they involve sharp or searing pain. People with ear infections sometimes suffer brief hearing loss and fever.

Children with ear infections may also display irritability or rub their ears. In some cases, pain that comes from the teeth or jaw extends to the ear.

Other potential causes of earaches include a tooth infection, arthritis that affects the jaw, a perforated eardrum or temporomandibular joint syndrome.

Earache that aggravates or persists after 24 to 48 hours requires a physician's diagnosis. An earache with accompanying symptoms, such as high fever, dizziness, headache or swelling near the ear, also needs proper medical care.

Using continuous real time monitoring
to monitor the effectiveness of manual and engineering controls for proactive management of airborne pollutants at Kopanang Mine

L. Kleynhans, L. Smith and M. Beukes
Kopanang Mine, Anglo Gold Ashanti

ABSTRACT

The Learning Hub MOSH Dust team together with industry identified continuous real-time monitoring of airborne pollutant engineering controls as one of the leading practices that will have a significant impact in addressing the risk and exposure of harmful airborne pollutants at source. Reducing this risk to underground employees will constitute a significant step towards achieving the ultimate goal of zero harm. The strategy adopted aimed to avoid potential inefficiencies due to the human factor and the need for continuous underground monitoring was identified. This paper describes the project that was undertaken to install and test a real-time dust monitoring system.

The Learning Hub MOSH Dust team together with industry identified continuous real-time monitoring of airborne pollutant engineering controls as one of the leading practices that will have a significant impact in addressing the risk and exposure of harmful airborne pollutants at source. This practice could enable industry to carry out predictive and preventative management on engineering interventions which control airborne pollutants.

1.1. Objective of monitoring

Death from silicosis caused by excessive exposure to silica dust is one of the greatest causes of mortality in mine workers. Reducing this risk to underground employees will constitute a significant step towards achieving the ultimate goal of zero harm.

Because the efficiency of current controls is normally dependent on the human factor, the strategy indicated a real need for a practice that provides consistent guidance and measurements for reliably identifying, implementing and monitoring current engineering controls underground. A need was then identified for continuous dust monitoring which allows for:

- Determining sources or causes of unsatisfactory conditions
- Detecting working places or processes with unsatisfactory dust conditions
- Evaluate exposure controls (Effectiveness / Control changes)
- Verification that satisfactory conditions have been achieved following the implementation of remedial measures
- Confirmation that satisfactory conditions are being maintained
- Determining risk levels (through appropriate risk assessments)
- On-going monitoring of the effectiveness of control measures
- Data on dust conditions to determine specific trends
- Shortfalls in the design of ventilation systems.

Original paper presented at the 2016 MVSSA Conference

1.2. Strategy for Monitoring

Instruments are placed strategically at identified sources of air-borne hazards and connected via and existing telemetry monitoring network to monitor the ambient air condition continuously in real time at an effective engineering control. It allows for immediate reaction and or intervention "TARP" when the continuous real-time monitoring unit detects exposure to unacceptable pollutant hazardous levels. With easy installation, low maintenance requirements, flexibility to be incorporated into the current monitoring systems in use and no consumables it has broad advantages. We will move away from reactive management mode into a more proactive approach while monitoring the whole mine simultaneously and continuously.

Thus, more time will be devoted to dust management and less on determining the source of the pollution. Our goal as an industry is to ensure that every employee returns home healthy on a daily basis and exit the industry healthy.

2. IDENTIFICATION AND EVALUATION

2.1. Methods

After following and identification process on Kopanang shaft, 14 continuous real time sampling units were installed on the intake and direct return air side of various controls, see Figure 1. The ambient air condition was then transmitted to a surface control room where it was monitored continuously in real-time.

Should a dust "alarm" occur and continue for more than 10 minutes, the control room operator would initiate a call out procedure to investigate the alarm. Following the investigation an action log should be put in place to rectify the condition. The air-borne pollutant data is interpreted and appropriate interventions and controls are proposed to prevent people from being over-exposed to harmful dust concentrations.

With the above process completed, the identified dust problem is effectively managed and employee's exposure reduced / eliminated completely.

It empowers the mine to continuously determine the efficiency of the current installed controls and serves as a confirmation that satisfactory conditions have been achieved following remedial actions.

3. PROJECT PHASES

3.1. Phase 1

Real-time dust monitoring sensors were installed in Kopanang Upper Mine "Vent District".

The trends analysed from the real time sampling instruments

Change in syllabus for new Certificate in MEC:

With exams commencing in October we want to share the information to our juniors, on the changes in the syllabus so they will understand the impact thereof.

Some motivation to study….

Index:

⇒ Current qualification

⇒ End date of current qualification

⇒ Progress with new qualification

⇒ The way forward

⇒ **Current qualification:**

Intermediate (NQF4)

Practical (use of instruments)

Paper1 and Paper2

Certificate in Mine Environmental Control (NQF6)

Paper 1— Fluid Flow Dynamics

Paper 2—Thermal Engineering

Paper 3—Planning, Economics, Technical Literature and information management

Paper 4—Risk Management, Fire and Explosions, Gases and Statistics

Paper 5—Occupational Hygiene

Paper 6—Legislation

⇒ **End of current qualification:**

The last registration for new entries will be October 2018 and registered Learners have until October 2020 to obtain their Intermediate Mine Environmental Control Certificate.

All candidates currently busy with Certificate in Mine Environmental Control will also have until October 2020 to complete their qualification.

⇒ **Progress with new qualification**

Two Qualifications have been registered

- Mine Ventilation Observer (NQF3)
- Mine Ventilation Officer (NQF4)

AQP (Assessment Quality Partner) has been established.

Learner Guides have been completed.

First SDP (Skill Development Provider) is currently being registered.

MVSSA have signed an agreement with Wits University for the development of an NQF6 qualification to replace the CMEC.

Have submitted the Mine Environmental Control Supervisor NQF7 qualification for registration through the QCTO (2-3 yr)

Lectures and Examiners/Moderators have been appointed for the 7 Modules

Literature for the qualification will be the MVSSA Workbooks & Textbooks except for the math's module.

Reviewing of the current workbooks will be done by the lectures.

Will consist of, 7 one week modules at WITS University. Examination will be two weeks after last day of lectures.

Submission of an assignment report two weeks after examination:

Module 1— Fluid Flow Dynamics

Module 2—Thermal Engineering

Module 3—Planning, Economics, Technical Literature and information management

Module 4—Risk Management, Fire and Explosions, Gases and Statistics

Module 5—Occupational Hygiene

Module 6—Legislation

Module 7—Math's

QCTO Qualification for distance learner's.

⇒ **The way forward:**

Complete work so that the NQF 3 & 4 qualification can be implemented:

- Mine Ventilation Observer (NQF3) - aimed pilot group to start in October 2017
- Mine Ventilation Officer (NQF4) - dependent on numbers aimed to be ready in October 2018

Reviewing of the current workbooks and drafting and vetting of lecturing material by end of 2017.

Aiming for first class in first half of 2018.

Tips on how to write a technical Paper:

The Abstract:

State the problem, your approach and solution, and the main contribution of the paper. Include little if any background and motivation. Be factual but comprehensive. The material in the abstract should not be repeated later word for word in the paper.

The Introduction:

The Introduction is crucially important. By the time a referee has finished the Introduction, he's probably made an initial decision about whether to accept or reject the paper, he'll read the rest of the paper looking for evidence to support his decision. A casual reader will continue on if the Introduction captivates him, and will set the paper aside otherwise.

Here is the Stanford InfoLab's patented five-point structure for Introductions. It should consist of five paragraphs answering the following five questions:

1. What is the problem?
2. Why is it interesting and important?
3. Why is it hard? (E.g, why do the previous approaches fial?)
4. Why hasn't it been solved before? (How does mine differ?)
5. What are the key components of my approach and results? Also include limitations.

Related work:

The perennial question: Should related work be covered near the beginning of the paper or near the end?

Beginning—if it can be short yet detailed enough, or if it's critical to take a strong defensive stance about previous work right away. In this case related work can be either a subsection at the end of the Introduction, or its own section 2.

End—if it can be summarized quickly early on (in the Introduction or Preliminaries), or if sufficient comparisons require the technical content of the paper. In this case related work should appear just before the Conclusions, possibly in a more general section "Discussion and Related Work".

The Body:

A clear new important technical contribution should have been articulated by the time the reader finished the Introduction.

Every section of the paper should tell a story. (Don't however, fall into the common trap of telling the entire story of how you arrived at your results. Just tell the story of the results themselves.) The story should be linear and keeping the reader engaged at every step and looking forward to the next step. There should be no significant interruptions, those can be Appendix; see below etc.

Aside from these guidelines, which apply to every paper, the structure of the body varies a lot depending on the content.

Important components are:

Running Example:

When possible, use a running example throughout the paper. It can be introduced either as a subsection at the end of the Introduction, or its own Section 2 or 3 (depending on the related work).

Preliminaries::

This section, which follows the Introduction and possibly related work and/or running example, sets up notation and terminology that is not part of the technical contribution. One important function of this is to delineate material that's not original but is needed for the paper.

Content:

The meat of the paper includes algorithms, system descriptions, new language constructs, analyses, etc. Whenever possible use a "top down" description: readers should be able to see where the material is going, and they should be able to skip ahead and still get the idea.

Performance Experiments:

We could have an entire paper on this topic , but here is some random points-

What should performance experiments measure?

1. Pure running time
2. Sensitivety to important parameters
3. Scalability in various aspects; data size etc
4. Problem complexity

What should performance experiments show?

1. Absolute performance(i.e It's usable)
2. Relative performance to naïve approaches
3. Relative performance to previous approaches
4. Relative performance to different proposed approaches.

The conclusion:

In general a short summarizing paragraph will do, and under no circumstances should the paragraph simply repeat material from the Abstract for Introduction. It's possible to make the original claims more concrete.

Future work:

This material is important , part of the value of the paper is showing how the work sets the research direction or change in work practices.

The Acknowledgements:

Acknowledge anyone who contributed in any way, through discussions, feedback on drafts, implementation, etc.

Appendices:

Appendices should contain detailed proofs and algorithms only. Appendices can be crucial for long papers but should not be used for understanding the contributions to the paper.

Never be scared to try, there is potentially no such thing an dumb idea… trust your intuition and believe that you can and make a difference!!!

The Mine Ventilation Society of South Africa

NEWSLETTER

Colliery Branch

February 2018,
Volume 14, Issue 1

Exam Dates 2018 & Registration

COST: R1000 PER PAPER

Papers	EXAMINATION DATES	
	MAY	OCTOBER
Survey Draught Theory	07 May 2018	08 October 2018
MEC Paper 1	07 May 2018	08 October 2018
Elem. Survey	08 May 2018	09 October 2018
Adv Survey Theory	08 May 2018	09 October 2018
Adv Survey Law	08 May 2018	09 October 2018
Strata Control Met	08 May 2018	09 October 2018
Strata Control Coal	08 May 2018	09 October 2018
RMC Paper 1	08 May 2018	09 October 2018
Elem Sampling	09 May 2018	10 October 2018
Adv Valuation	09 May 2018	10 October 2018
Survey Draught Practical	09 May 2018	10 October 2018
MEC Paper 2	09 May 2018	10 October 2018
RMC Paper 2	09 May 2018	10 October 2018
MEC Paper 3	10 May 2018	11 October 2018
RMC Paper 3.1	10 May 2018	11 October 2018
RMC Paper 3.2	10 May 2018	11 October 2018
RMC Paper 3.3	10 May 2018	11 October 2018
RMC Paper 3.4	10 May 2018	11 October 2018
MEC Int Paper 1	11 May 2018	12 October 2018
MEC Paper 4	11 May 2018	12 October 2018
MEC Int Paper 2	14 May 2018	15 October 2018
MEC Paper 5	14 May 2018	15 October 2018
MEC Paper 6	15 May 2018	16 October 2018

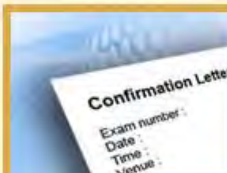
Step by Step Guide

Step 1

Select exam required, complete the on line registration form.

Step 2

Fax or e-mail the proof of payment

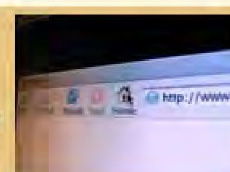


Step 3

On receipt of the proof of payment you will receive a confirmation letter indicating the date, time and venue where the exam will be written.

Step 4

After the exams have been written, scripts marked and marks approved by the examination committee, these marks will be available on the website.



Banking Details: Chamber of Mines
Bank: First National Bank, Main Street
Branch Code: 251705
Acc No: 50510477760

For more detail visit the MVS Web Page or the CoM Web Page.

The Mine Ventilation Society of South Africa

NEWSLETTER

Colliery Branch

January 2018,

Volume 14, Issue 1

Exam Question and Answer

EXAMINATION FOR THE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL

PAPER 3; October 2017: Question 2 [20 marks]

2. In a highly mechanized mine a minimum ventilation quantity is often set by supplying 0,06 m3/s of air per kW of diesel equipment used. Comment on this value using the following information:

The fuel consumption of a rated 55 kW diesel LHD is 8,6 kg/hr when hauling and 2,3 kg/hr when idling. The following table gives the exhaust gas analysis for the two situations:

Equipment	Exhaust gas	% CO_2	% CO	% NO_x
Idling	12.6 m^3/kg of fuel	0.73	0.04	0.0022
Hauling	62.3 m^3/kg of fuel	4.71	0.058	0.0191

The following are the maximum allowable concentrations of diesel exhaust gases in the general air stream:

- **CO2 5000 ppm**
- **CO 100 ppm**
- **NOx 5 ppm**

Assume that normal air contains 300 ppm of CO_2 and 0 ppm CO or NOx.
{HINT: You will need to calculate the quantity of exhaust gas produced as well as the quantity of the fresh air required in both situation when the LHD idling and hauling to be able to comment on the dilution factor}

ANSWER:
Diesel Equipment idling:
Fuel used = 2.3 kg/hr
Gas produced 12.6 m^3/kg

The quantity of gas produced = m^3/kg x fuel consumption
= (12,6 x 2,3)/3 600
= 0,00805 m^3/s

From this quantity of exhaust gas, the various quantities of CO_2, CO and NOx must be calculated:

The quantity of CO_2 = % CO2 x Qexhaust
= 0,73/100 x 0,00805
= 0,0000588 m^3/s

The quantity of CO = % CO x Qexhaust
= 0,04/100 x 0,00805
= 0,00000322 m^3/s

The quantity of NOx = % NOx x Qexhaust
= 0,0022/100 x 0,00805
= 0,0000001771 m^3/s

The amount of fresh air for each of the above quantities of gas must be determined:

Qfresh to dilute CO_2
= $Qgas\ x$ 106 $MAC{-}N - Qgas$
= 0.0000588 x 106 5000−300 − 0.0000588
= 0.0124 m^3/s

Qfresh to dilute CO
= $Qgas\ x$ 106 $MAC{-}N - Qgas$
= 0.00000322 x 106 100−0 − 0.00000322
= 0.0322 m^3/s

Qfresh to dilute NOx
= $Qgas\ x$ 106 $MAC{-}N - Qgas$
= 0.0000001771 x 106 5−0 − 0.0000001771
= 0.035 m^3/s

For idling the air quantities are very low

Diesel equipment hauling
Fuel used = 8,6 kg/hr
Gas produced = 62,3 m^3/kg

The quantity of gas produced = m3/kg x fuel consumption

The Mine Ventilation Society of South Africa

NEWSLETTER

Colliery Branch

February 2018,

Volume 14, Issue 1

= (62,3 x 8,6)/3 600
= 0,14883 m^3/s

From this quantity of exhaust gas, the various quantities of CO2, CO and NOx must be calculated:

The quantity of CO2 = % CO2 x Qexhaust
= 4.71/100 x 0,14883
= 0,007 m^3/s

The quantity of CO = % CO x Qexhaust
= 0,058/100 x 0,14883
= 0,00009 m^3/s

The quantity of NOx = % NOx x Qexhaust
= 0,0191/100 x 0,14883
= 0,00009 m^3/s

The amount of fresh air for each of the above quantities of gas must be determined:

Qfresh to dilute CO2
$= Qgas\ x\ 106\ MAC{-}N - Qgas$
$= 0.007\ x\ 106\ 5000{-}300 - 0.007$
= 1.48 m^3/s

Qfresh to dilute CO
$= Qgas\ x\ 106\ MAC{-}N - Qgas$
$= 0.00009\ x\ 106\ 100{-}0 - 0.00009$
= 0.86 m^3/s

Qfresh to dilute NOx
$= Qgas\ x\ 106\ MAC{-}N - Qgas$
$= 0.00003\ x\ 106\ 5{-}0 - 0.00003$
= 5.686 m^3/s

The results can be tabulated as follows:

Equipment	Quantity of air required to dilute (m^3/s)		
	CO_2	CO	NOx
Idling	0.013	0.0322	0.0353
Hauling	1.5	0.86	5.7

If a quantity of 0,06 m^3/s of air per kW of diesel equipment was supplied, each diesel LHD would require the following amount of air: 10

Air quantity required = 55 x 0,06
= 3,3 m^3/s per LHD

As can be seen from table summary above, the amount of air (3,3 m^3/s) will not be sufficient to dilute the NOx gases when the LHD is hauling.

A new quantity of air supplied per kW of equipment should be advised or the high NOx emissions must be investigated. In the case of the NOx gases being "normal" for that type and possible age of machinery, a new air factor ($m^3/s/kW$) can be determined as follows:

Air factor = Quantity of air / kW
= 5,7 / 40
= 0,143 m^3/s per kW ***[20 Marks]***

Interesting Reads:

Headline: Cooling Systems in demand as mines expand in Africa

Link: http://www.miningweekly.com/article/cooling-systems-in-demand-as-mines-expand-in-africa-2017-11-10

Headline: Ventilation and cooling in mines often work against nature

Link: http://www.miningweekly.com/article/ventilation-and-cooling-in-mines-often-work-against-nature-2017-11-24