AiroDust Comparative Testing

Matt Ryan
Director

Mining Attachments (Qld) Pty Ltd

Controlling the risk of coal dust explosions

Maintaining stone dust compliance is a key control in the prevention of coal dust explosions in underground coal mines.

The application of dry stone dust contaminates the mine ventilation with inhalable dust well above the recommended limits for personal exposure.

Mining operations maintain a balance between production needs and compliance and schedule non production events to carry out dry stone dusting.

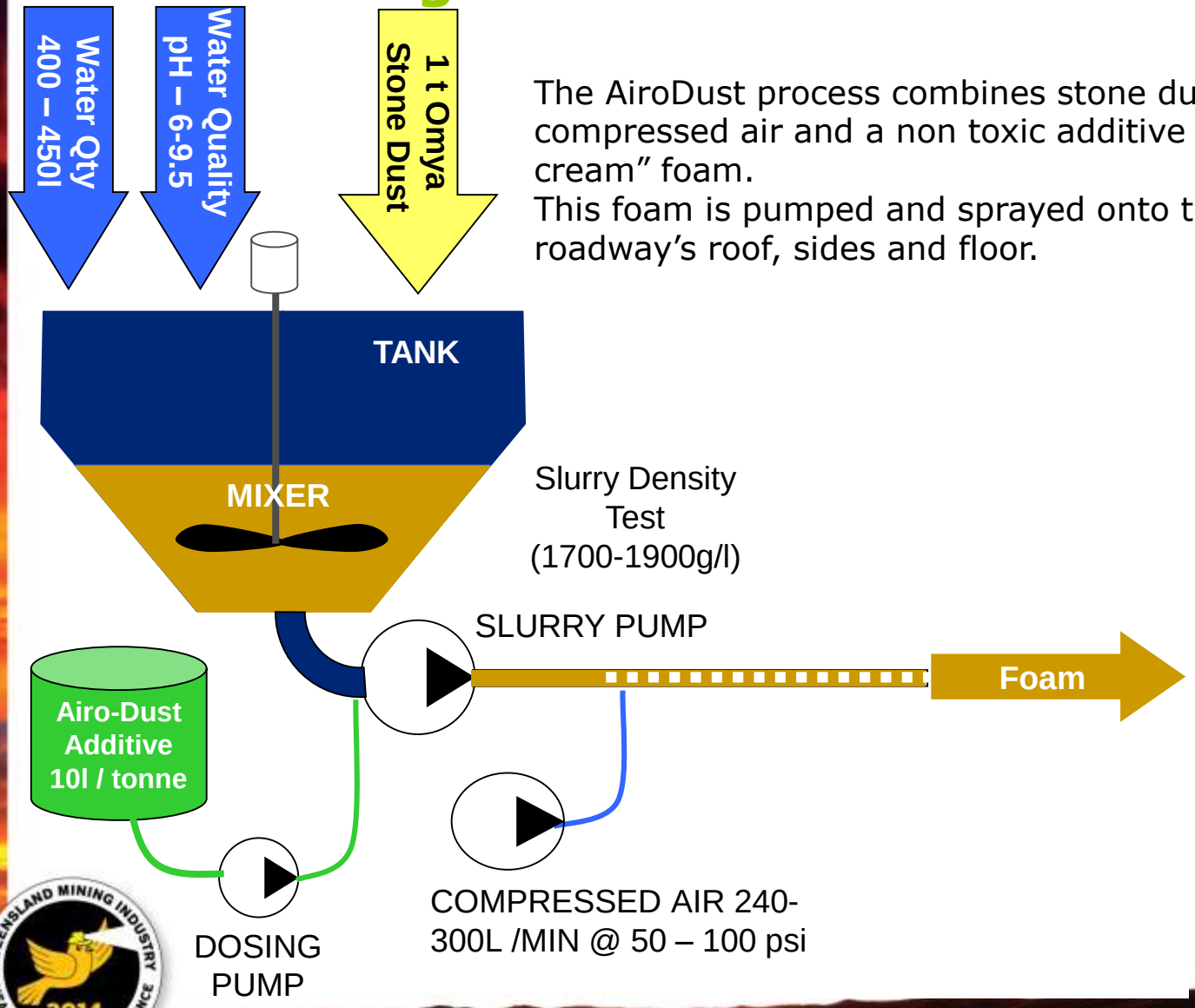
Attempts have been made to apply stone dust wet to minimise these non production events.

Research discovered that wet stone dusting alone IS NOT a long term control to mitigate the risk of a coal dust explosion.

As the wet stone dust slurry dries, it cakes and hardens, raising doubts over its ability to be raised into suspension during a methane blast.

Dry stone dust contaminates the inbye atmosphere
Wet stone dust alone IS NOT a long term coal dust explosion control

Introducing AiroDust



The AiroDust process combines stone dust, water, compressed air and a non toxic additive to create a "shaving cream" foam.
This foam is pumped and sprayed onto the underground roadway's roof, sides and floor.

Underground AiroDust application

This film clip shows an operator working in the intake of a Longwall panel during production and around mine traffic. AiroDust provides continuous opportunity to maintain stone dust compliance.

Alternate method of applying stone dust

AiroDust was invented to prevent stone dust caking and provide a stone dusting process that can be applied anytime without effecting other mining activities.

A system to enable the proactive design of a mines stone dusting treatment plan that would match stone dust application and reapplication to float coal dust deposits. The system would also allow for an immediate response to any non compliant areas.

In these challenging times, a designed system minimises the waste of resources due to the inefficiencies that occur during reactive planning.

Designed for the underground coal industry
Proactive design minimising waste
A no excuse stone dust compliance system

ACARP funded research

Research into the effectiveness of AiroDust as an alternate method of applying stone dust in underground coal mines commenced in 2004.

The objective of the research was to:

- ✓ Identify any difference between dry stone dust and AiroDust
- ✓ Identify the elements of AiroDust
- ✓ Measure the effects of each element to establish the minimum and maximum tolerances
- ✓ Establish the recommended guidelines of use
- ✓ Conduct full scale coal dust explosion suppression testing and compare AiroDust's performance against the effectiveness of dry stone dust
- ✓ Collect sufficient data to enable the assessment of the design risks
- ✓ Provide senior site executives with research information that enables operational risk assessment

10 years of research into the effectiveness of AiroDust
The following slides provide a summary of this work

Independent researchers were selected

The research was designed to establish a proven set of manufacturers specifications to produce a foamed stone dust using the AiroDust process.

AiroDust manufactured to the required specification was then tested to measure its effectiveness in supressing a coal dust explosion in the South African Kloppersbos explosion tunnel.

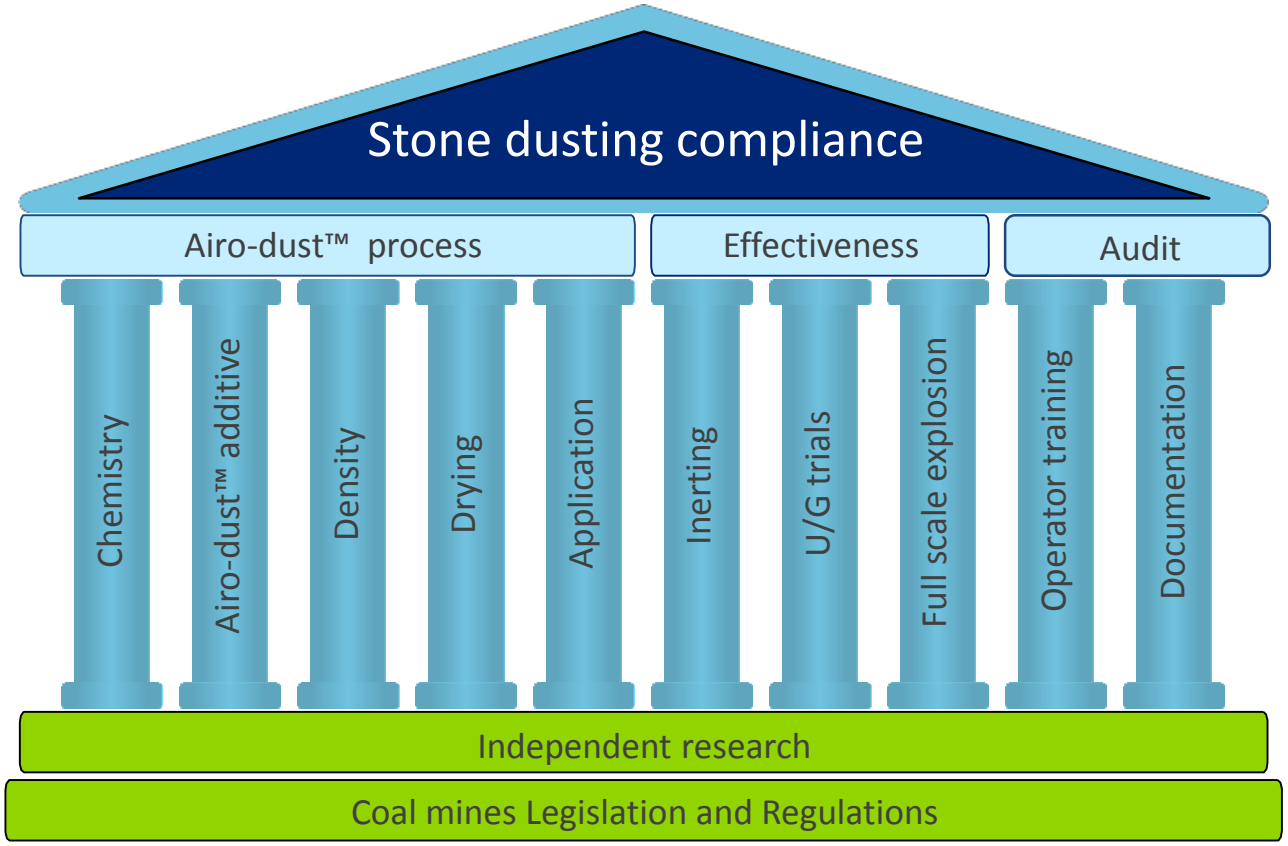
The following researcher companies have conducted research into the AiroDust process

- ✓ SIMTARS
- ✓ Gillies Wu Mining Technology Pty Ltd
- ✓ Tim Harvey (AUS, Consultant)
- ✓ Monash University
- ✓ Ian Wark Research Institute
- ✓ University of Queensland
- ✓ CSIR
- ✓ Dr Jan du Plessis and Dr Huw Phillips (South Africa, Consultants)
- ✓ Martin Hertzburg (USA, Consultant)

Leading experts in their specific fields were approached to conduct the necessary research

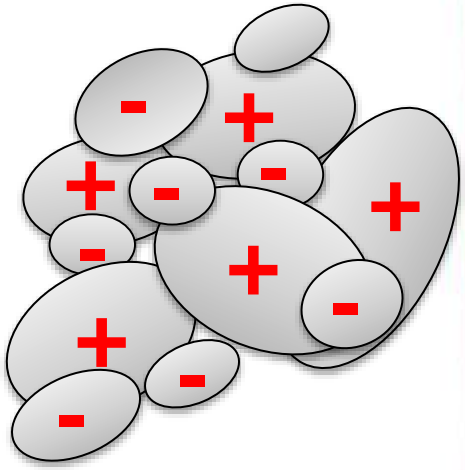
Coal mining legislation and regulations provide sound foundations

Maintaining stone dust compliance involves working within each elements designed parameters.



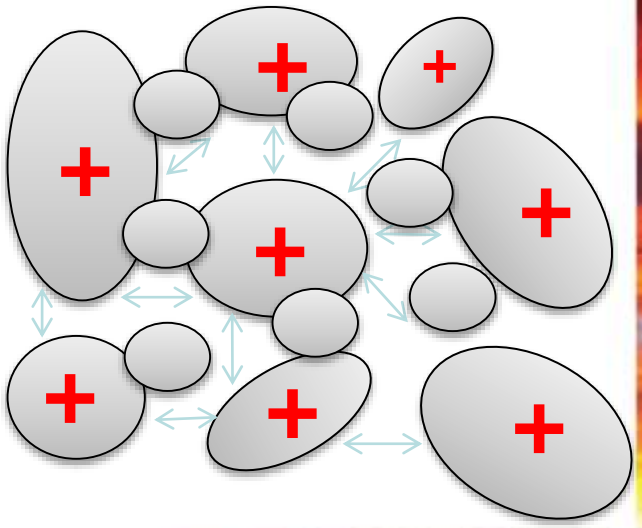
Chemistry

When water is added, the stone dust slurry undergoes a re-crystallization process as it dries resulting in caking.



The AiroDust Additive neutralises the negatively charged particles and eliminates their action of drawing the positively charged particles together resulting in reduced caking of the dried product.

The AiroDust additive was engineered to prevent stone dust caking.



AiroDust Additive

The surfactants in the AiroDust Additive can be found in every day household products such hand soap, fabric softener, shampoo and hair conditioner.

AiroDust Additive is classified as "hazardous" by NOHSC in an undiluted form due to the de-fatting effect on skin.

During application the additive is diluted with the water in the stone dust slurry and is classified by NOHSC as "non-hazardous".

Ian Wark Research Institute tested the surface charge of stone dust particles during the addition of the AiroDust Additive in a range of waters to measure the dosage and pH tolerances.

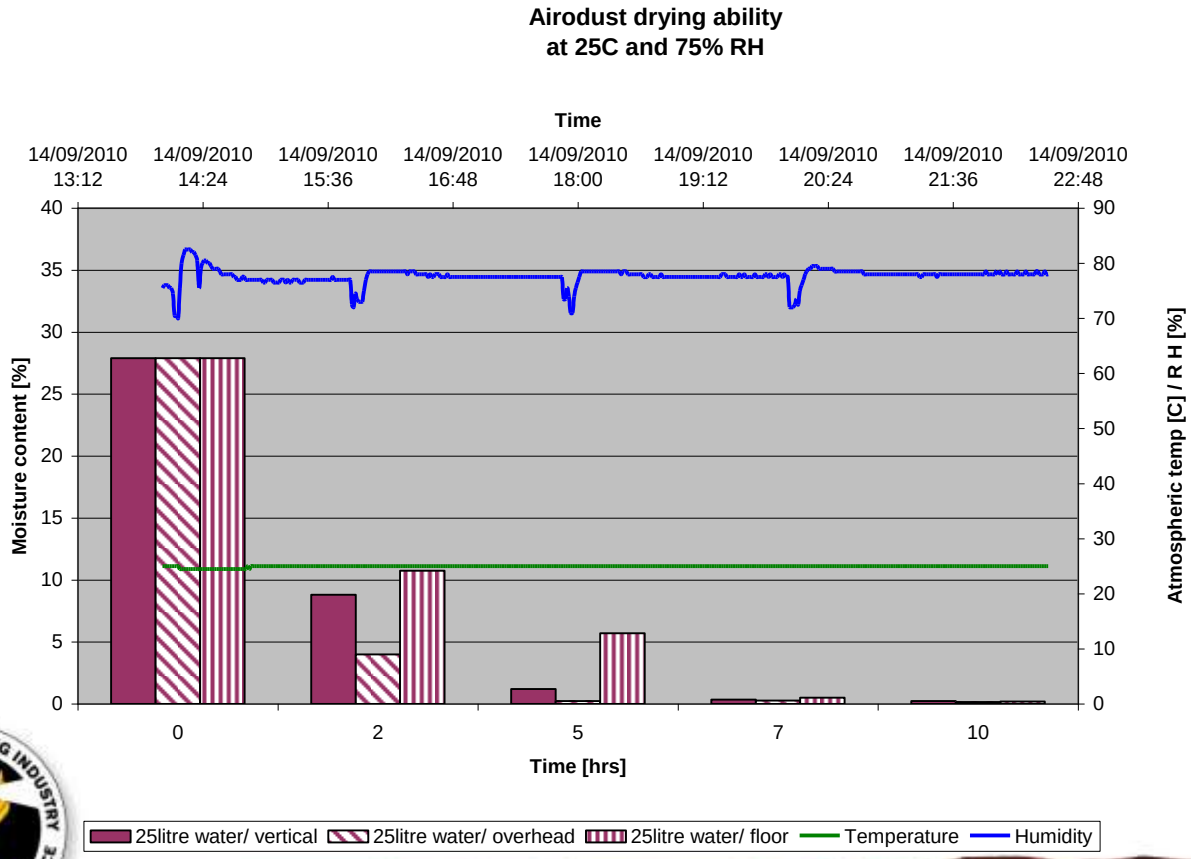
A recommended water pH and ADA dosage rate was established for a range of Australian and South African stone dusts.

The AiroDust additive is defatting to the skin, the MSDS recommends PVC gloves and glasses During spraying the stone dust slurry is non hazardous, the MDSD recommends goggles to be worn.

Drying

SIMTARS conducted controlled oven drying tests on AiroDust.

The result show that the product is dry in temperatures ranging between 20˚ C and 25˚ C with humidity levels between 75%RH and 90%RH in 7 – 18 hours.



Additional drying testing is planned for the next phase of under ground tests

Recommended guidelines

Independent testing of the AiroDust product created the minimum and maximum parameters.

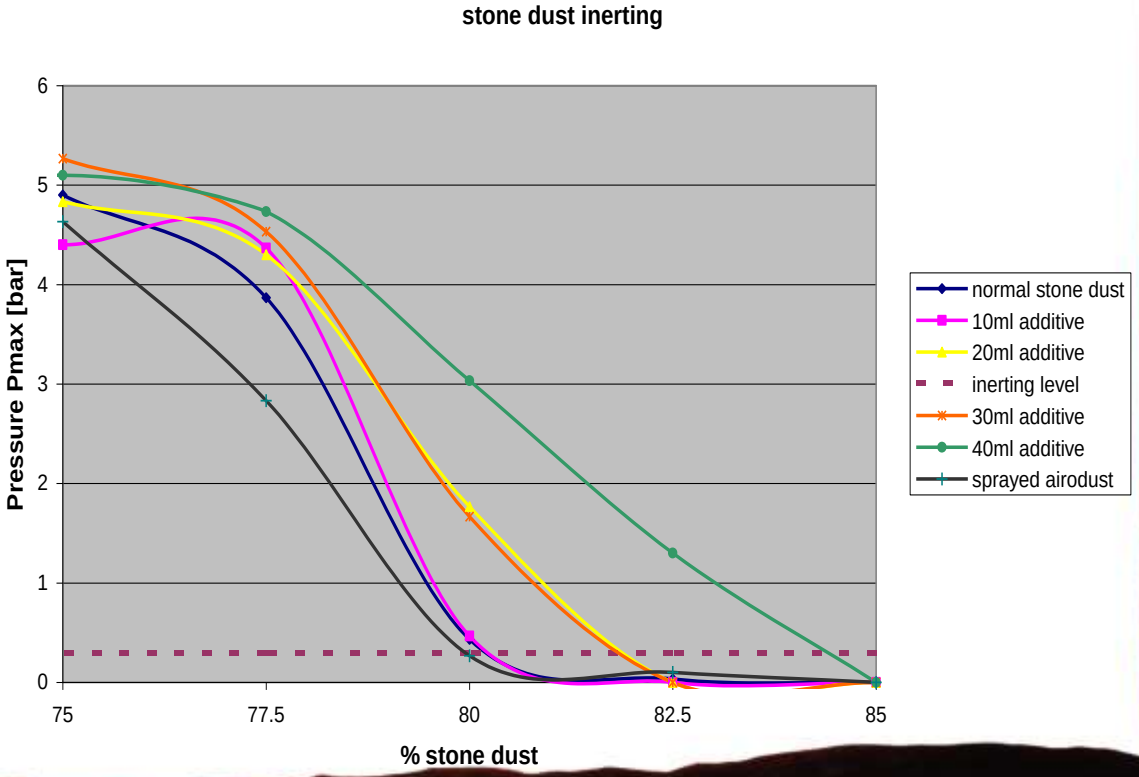
AiroDust Recommended Guidelines			
Elements	Minimum	Maximum	Units
Stone dust type	Only Coal Mine Approved Stone Dust		
Additive type	Only Airo-dust™ additive		
Water pH	6.0	9.5	pH
Total dissolved electrolytes	0	10 000	PPM
Water quantity	400	450	Litres / 1000kg of dry stone dust
Airo-dust™ additive	5	12	Litres / 1000kg of dry stone dust
Density (Slurry)	1700	1900	Grams/ litre
Density (Foam)	300	500	Grams/ litre
Spray hose length	0	80	Metres

Inerting

At the recommended dosage there is no difference in the inerting ability between stone treated with the AiroDust process and normal dry stone dust, using the 20 litre Siwek Chamber.

The AiroDust product and the dry stone dust were successful in suppressing the coal dust explosions generated in the SIMTARS propagation tube.

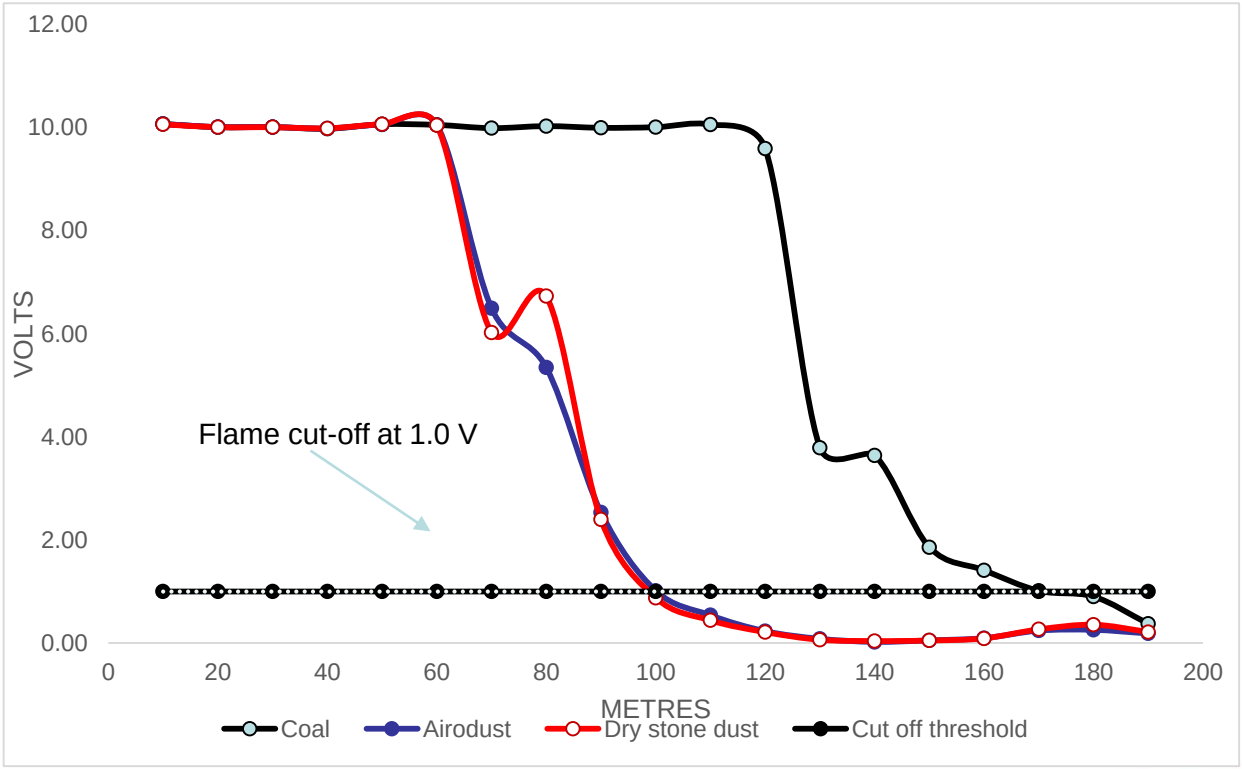
Stone dust that is correctly treated is the same as dry stone dust



Full scale explosion testing

CSIR conducted 30 inerting tests using the internationally recognised 200 metre Kloppersbos explosion tunnel in South Africa.

Independent statistical analysis has shown that the level of confidence of 99.25% of AiroDust and dry stone dust stopping an explosion in the Kloppersbos tunnel within 20m of each other is 99.25%



All full scale tests successfully extinguished the coal dust explosion.

Full scale explosion testing

This film clip shows a coal dust explosion when the is no AiroDust in the second fuel zone.

Full scale explosion testing

This film clip shows a coal dust explosion with 100% AiroDust in the second fuel zone.

Full scale explosion testing

This film clip shows a coal dust explosion with 80% AiroDust and 20% coal dust in the second fuel zone.

Design Risk Assessment

A system design risk assessment was completed on the 29th of April 2014.

A cross section of industry experts included underground operators , OEM, researchers, SSE's, coal dust explosion expert, ISHR all participated.

The assessment covered the manufacturing of the AiroDust foam and its effectiveness as a coal dust explosion control compared with the dry stone dust process.

The objective of the risk assessment was to determine if:

1. Any part of the process:
    a. Alters the stone dust in such a way that it becomes ineffective in supressing a coal dust explosion.
    b. Can harm or contains an unacceptable level of risk to the health and safety of coal mine workers.
2. Has the effectiveness testing:
    a. Demonstrated beyond reasonable doubt that if applied with the designed guidelines and parameters, AiroDust will suppress a coal dust explosion with the same result as dry stone dust.

The design risk assessment group agreed the AiroDust process was at an acceptable level of risk with a number of additional controls.

Design Risk Assessment Actions

The main actions from the design risk assessment include:

1. Low energy explosion testing
   - ✓ Conduct 9 full scale tests with a low energy coal dust explosion
2. Additional under ground application testing
   - ✓ Monitor the drying of the AiroDust foam in the underground environment
   - ✓ Measure the coal dust deposits on AiroDust and dry stone dust
   - ✓ Monitor the equipment and personnel to create AiroDust foam within the design guidelines in the underground environment

The under ground application testing is not funded as a part of this research project and has now moved into commercialisation.

Once commercial terms are agreed between the owners of AiroDust and the selected coal companies, the additional underground application testing can commence.

Additional data will assist in further understanding the long term characteristics of the AiroDust process

Operational Risk Assessment

An operational risk assessment was completed at two Queensland operations on the 2nd and 3rd of July 2014.

A cross section of the mines personnel included underground operators , ventilation officers, managers, outbye coordinators and Industry Safety and Health Representatives all participated.

The assessment covered the application of the AiroDust foam and its use in the under ground mine.

The objective of the risk assessment was to determine if:
Any part of the process presents a risk to the health and safety of the workers in the mine.

The operational risk assessment group agreed the AiroDust process was at an acceptable level of risk for introduction into the mine.

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Where to from here

Recognised coal dust explosion experts, Phillips and Du Plessis, suggested AiroDust should be tested in low energy explosion conditions.

This work has commenced in South Africa following similar testing protocol used in the previous full scale testing.

When the coal dust in the first fuel zone is distributed on the floor is creates a weaker strength explosion compared to the previous full scale testing. This is due to a leaner fuel air mixture.

Testing is expected to be complete by the 15th of September 2014.

The additional underground testing is awaiting final commercial terms to be agreed with the OEM and the trial sites.

This project is in final stages of completion and subject to this additional testing results, is soon to be commercially available.

Industry regulators are aware of the product and the process of testing and controlled introduction.