Appendix 1.0-Y Power Chem, Dubois Chemical, Chemical Agent Selection for TAC and Processed Coal

TELKWA COAL
LIMITED

August 28, 2018

Allegiance Coal
Tenas Metallurgical Coal Project

TECHNICAL REPORT:

Dust Suppressant Screening for Allegiance Coal

Situation Analysis:

The project has been the subject of an enormous amount of historical exploration and evaluation by previous owners estimated in today's dollars to be in the order of $40M. In 2017, Allegiance completed two pre-feasibiilty studies, the 'Staged Production PFS' and the 'Stage 1 PFS' both of which delivered outstanding results. On the basis of these results, Allegiance resolved to proceed to develop the Tenas resource, which is now the subject of a full feasibility study in 2018, referred to as the Tenas Metallurigical Coal Project.

The Tenas Project will use a 'small mine' approach, which would see annual production of between approximately 240,000 to 900,000 metric tonnes over an estimated 40-year period. The metallurgical or steelmaking coal would be shipped 375km on the CN rail line to Prince Rupert's Ridley Terminal for export to steel mills.

Allegiance Coal requested analysis and subsequent results of using Power Chemicals Ltd.'s technologies on Tenus Project coal to reduce process related, stockpiling and transportation dust generation.

Testing Protocols, Results & Recommendations:

Allegiance Coal provided samples for testing on June 28th, 2018. These samples were tested in our laboratory to determine surface characteristics and develop the best technology for the Tenas Coal for; Railcar Topper, Conveyed Dust Suppression and Stockpile Treatments. All products tested have been screened for coking process impact.

Railcar Topper Testing:
The coal used to evaluate Railcar Topper crust quality was determined to be 9% moisture. Envirobind DCT, APS and APS2 were all evaluated for crust quality as well as performance through the high velocity wind tunnel. The crust quality test determined DCT and APS2 to be very similar. The lab chose to continue the wind tunnel testing with the DCT.

Table 1. Crust quality of samples of samples treated.

Product	DCT	APS	APS2
Crust weight (g)	103.45	67.64	112.52
Crust height, range (cm)	2.5-3.0	1.2-2	2.5-3.0
Crust height, average (cm)	3.0	1.5	3.0
Break weight (g)	350	250	400
Observations	Intact. Crust is dry.	In two pieces. White in colour.	Intact. White in colour.

Table 2. Mass and % Coal lost in 100km/hr windtunnel

Measurement	DCT	Control
Mass of Coal/Treatment Lost (g)	8.01	717.81
% Coal Loss	0.99	89.22
Observations	Crust looked good. Very little blew away.	No crust, dry coal. Nearly all blew away within seconds.

Figure 1a:Untreated coal after windtunnel

Figure 1b: DCT treated coal after windtunnel

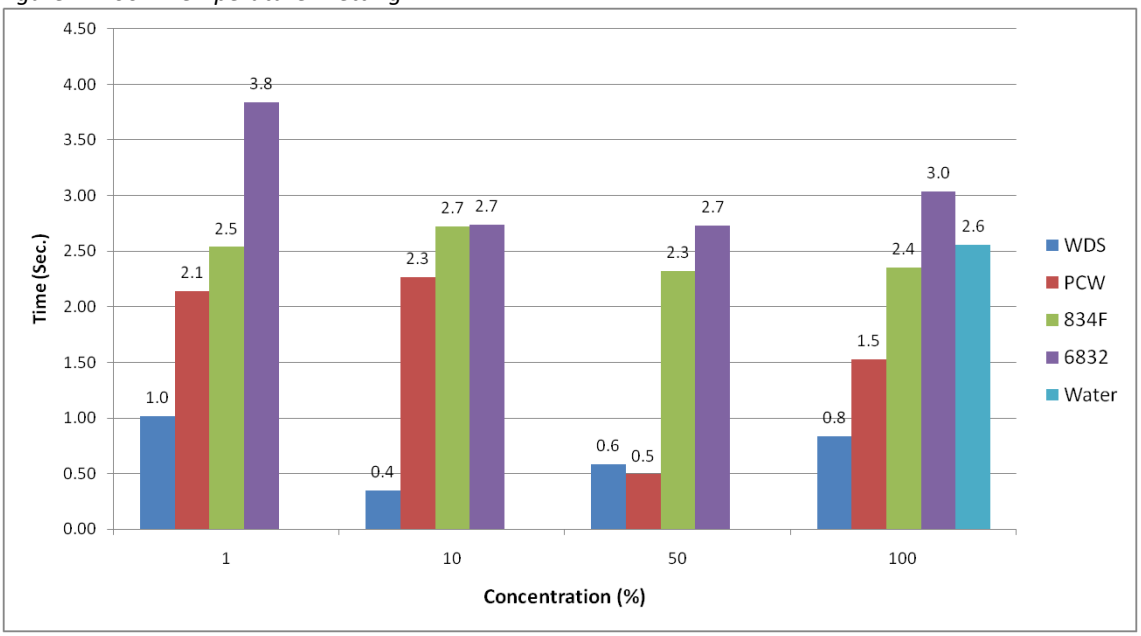
Product and Dosage Recommendation:

- Envirobind APS2 is recommended as a car topper solution for Tenas Coal
- Recommended dosage is 200g APS2/railcar diluted in 65-70 L of water/railcar.
- Recommend APS2 over DCT mainly due to lower equipment capital costs. Both products perform similarly and are in use in the BC Coal transport system.

Conveyed Dust Suppression:
Wetting tests were used to determine of the optimum chemistry for conveyed applications.

(Wetting Tests: The speed at which a droplet of chemical dust suppression covers, or wets-out, a surface is directly related to the performance for immediate dust suppression.)

Figure 2: Room Temperature Wetting



Envirobind WDS showed the fastest wetting times across the all concentrations with the exception of 50% where PCW is slightly quicker. The quicker time of 0.1 second is not significant. Also, it is important to note that water had a wetting time of about 2.6 seconds, which was outperformed by all except for 834F at 10% and 6832 at all concentrations.

Product and Dosage Recommendation:

- Envirobind WDS is recommended technology for conveyed dust suppression, and is used at Vancouver Terminals and various Coal Mining operations in BC.
- WDS performs very well over multiple transfer points and typically provides 3-4 days of residual dust suppression.
- Recommend a dosage of 30ppm (g/MT) as a 1% solution.

Stockpile Dust Suppression:

50 g piles were prepared and treated with 0.5 kg/$m^{2.}$ Treatments were applied at a concentration of 10%. Piles were dried overnight under solar lamps. Piles were then placed in the wind tunnel set to 40 Hz for 5 minutes.

Table 3: Mass and percent coal lost in wind tunnel after 5 minutes for ET and 829C samples

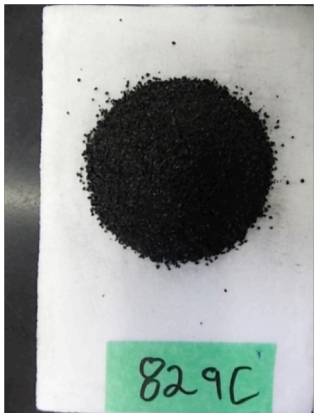
	ET	829C
Mass of Coal Loss in Wind Tunnel (g)	44.64	1.18
Percent Loss in Wind Tunnel (%)	89.26	2.36

Figure 2a: ET stockpile before wind tunnel

Figure 2b: ET stockpile after wind tunnel

Figure 3a: 829C stockpile before wind tunnel

Figure 3b: 829C stockpile after wind tunnel



Product and Dosage Recommendation:

- Envirobind 829C is recommended technology for stockpile dust suppression, and is in use at Vancouver area Terminals and BC Coal mines.
- Recommend a dosage of 100g/m2 as a 10% solution for up to 1-year effectiveness.
- Size of stockpile and length of treatment time should be considered, as reduced dosage can be used for shorter time of effectiveness.

Service and Support:

Power Chemicals representatives provide regular, technical service and support to all our customers. For startup, we provide on-site support by our Engineering Dept. and our sales team to ensure proper installation of equipment and optimization of dosage.

References are available upon request.

Thank you for your interest in Power Chemicals Ltd.

Best regards,

Anoop Buttar
Mining Solutions

Power Chemicals Laboratory Report

Subject: PXP-3067 Allegiance (Telkwa) Road Analysis

Date: January 10, 2019

Introduction:

A road substrate was received from Allegiance and was analyzed to determine several properties, such as initial moisture content, particle size distribution, breaking strength, dustiness and washout.

1. Moisture Content

a. Initial Moisture Content

Moisture content of 5-15% is expected for road substrates. Application of a road dust suppressant is not recommended when road surface is oversaturated. For the case of the Allegiance Road, it was determined that the Allegiance Road contains 9.07% moisture.

Sample	Moisture Content
Allegiance	9.07%

b. Optimum Moisture Content

Optimum moisture content is determined by generating a moisture-density curve for the aggregate. Compaction of road aggregate at the optimum moisture level results in the highest density. Based on the curve obtained in Figure 1, the optimum moisture content required to achieve the maximum compaction density of 22% to 25% for Allegiance Road.

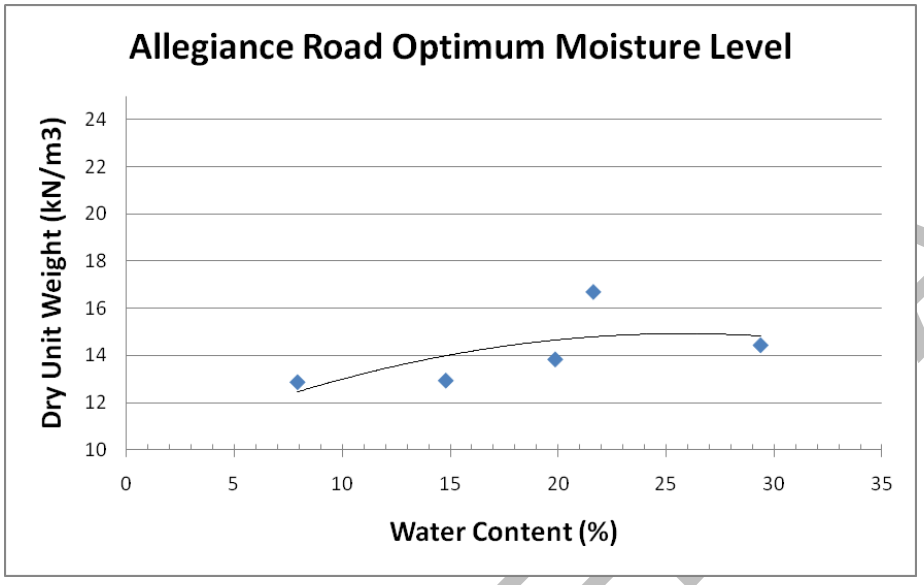


Figure 1: Moisture-density curve of Allegiance Road sample

2. Particle Size Distribution/Gradation Analysis

Particle size distribution (gradation) analysis was performed using Ro-Tap RX 29 sieve shaker with a nested column of ASTM sieves. A representative weighed dry sample is poured onto the top sieve, which has the largest screen openings, while samples with particle sizes greater than an inch were excluded in this analysis. Each subsequent sieve in the column contains smaller screen openings than the one above. The sieve shaker shakes the column for a set amount of time. After the shaking is complete, the material on each sieve is weighed. The weight of the sample for each sieve is then divided by the total weight to give a percentage retained on each sieve. Results are presented in Figure 2.

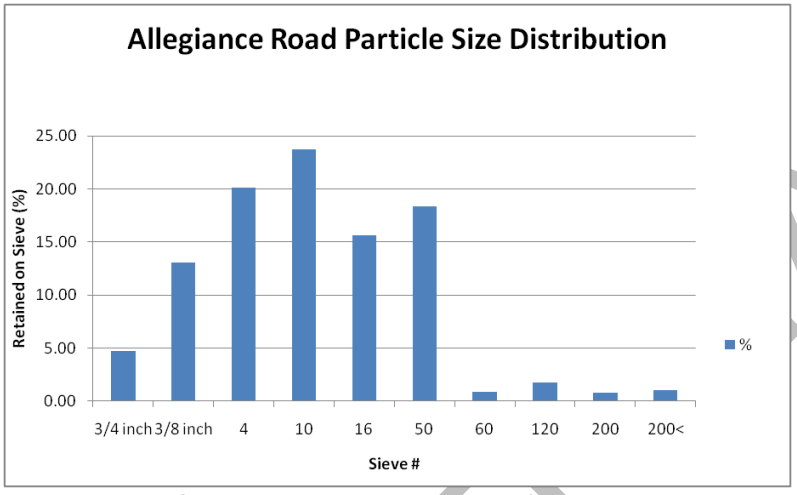


Figure 2: Particle Size Distribution analysis of Allegiance Road samples

A summary of the main grain sizes (based on Wentworth-Grain-Size-Chart) found in Allegiance Road is shown below. Portion on each sieve is assigned to a specific grain size category. Amount of material present in the clay/silt category is a useful indicator of performance and can influence treatment decisions. The Allegiance Road sample contains 1% of fines.

Material	%
Clay/Silt	1.00
Sand	37.36
Gravel	61.64

Table 1: Grain size distribution of Allegiance Road sample

3. Strength Test

Strength test was performed on 50 g compacted Access Allegiance Road substrates substrates treated with 6 g of 30% calcium chloride (aqueous solution) or Envirobind 891E. The strength test results are shown in Figure 3. For the Allegiance Road sample, an average pressure of 419 psi was required to break samples treated with Envirobind 891E while only an average pressure of 174 psi was required to break samples treated with 30% calcium chloride solution.

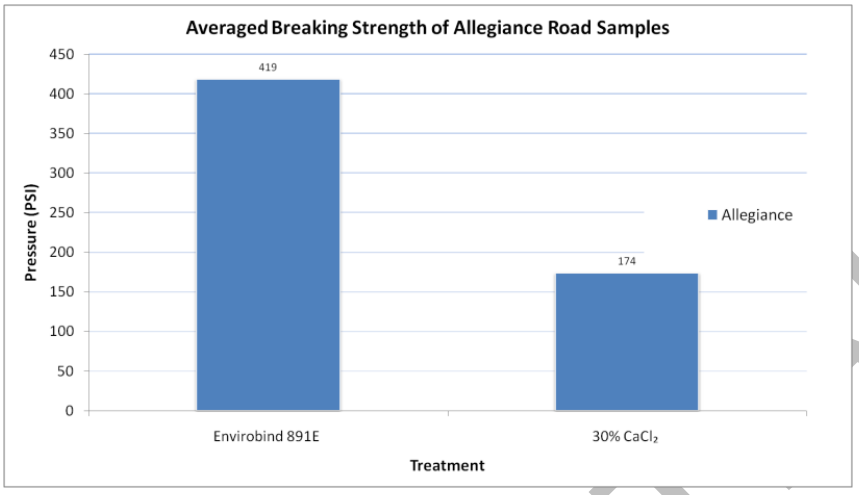


Figure 3: Comparison of strength performance for Allegiance Road treated with Envirobind 891E or 30% calcium chloride

4. Dustiness Test

Once broken in the Strength test, samples are sieved for one minute though a 125 µm sieve using Ro-Tap RX 29 at intervals of ten seconds to determine the amount of fines generated overtime. Results are shown in Figure 4. For the Allegiance Road samples, Envirobind 891E treated samples generated an average total of 3.87 g of dust after 60 seconds on the Ro-Tap compared to calcium chloride treated samples generated 7.14 g of dust after 60 seconds.

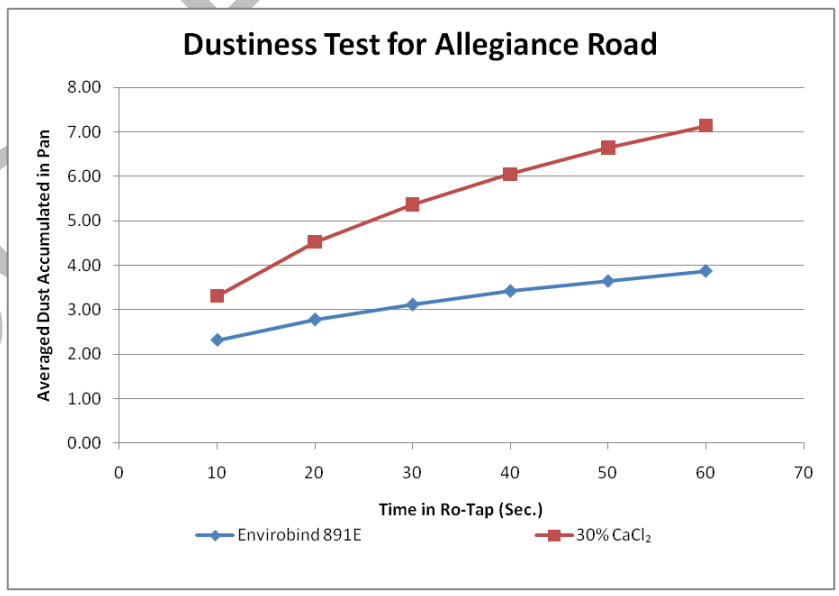


Figure 4: Comparing dustiness of treated Allegiance Road with Envirobind 891E or 30% calcium chloride sample

5. Washout Test

In the Washout test, 75 g of substrate is combined with 9 g of treatment and compacted into 2 inch pucks, which are cured overnight. These cured pucks are then sprayed with water using a pressurized nozzle until total disintegration. The number of spray cycles is measured.

As shown in Figure 5, the Allegiance Road puck treated with 30% calcium chloride disintegrated after 22 runs, while it took 25 runs for Envirobind 891E. Even though the number of laps it took for the Envirobind 891E samples to disintegrate is much less than the previous results, it still performs better than the competitor's treatment, calcium chloride.

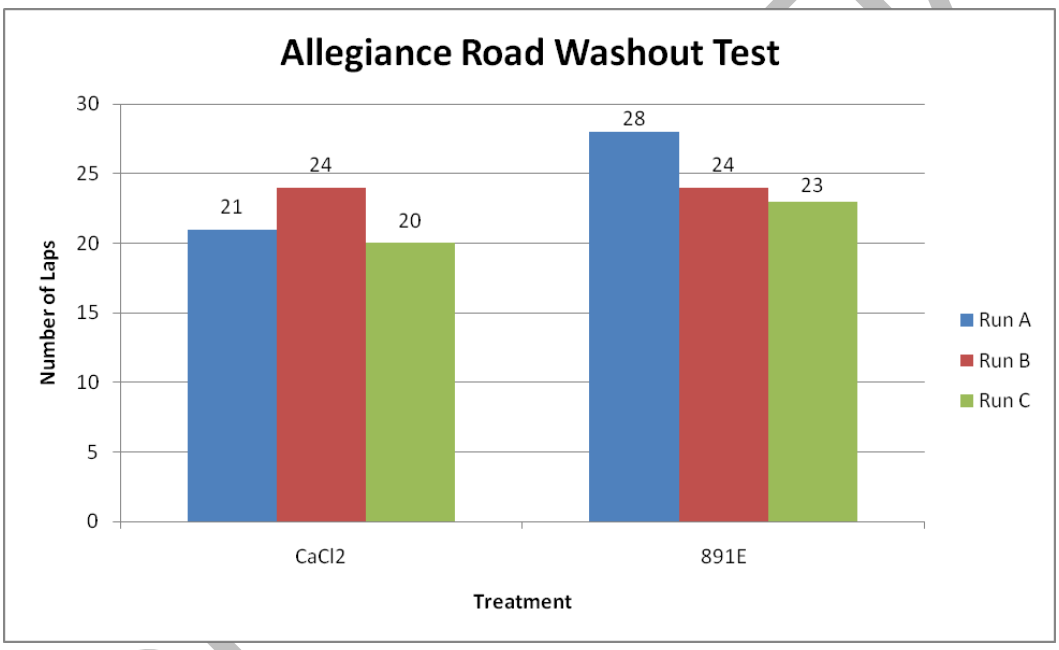


Figure 5: Comparing Washout performance of Allegiance Road treated with Envirobind 891E or 30% calcium chloride (aq.)

Power Chemicals Laboratory Report - CONFIDENTIAL

Subject: Product Testing for Allegiance Coal

Date: October 9, 2020

Prepared by: Chaklin Leung - Chemistry Laboratory Technician

Reviewed by: Tibor Horvath – Technical Director
Anoop Buttar – Mining Solutions Account Manager

Overview

Currently, the regulating body is challenging the client on their stockpile treatment plan including the winter months. During discussions with the client, ET was promoted as a very versatile product with year-round capability at a great value. Unfortunately, the report distributed does not give the client confidence. Therefore, another round of testing is performed to target the following concerns:

- WDS effectiveness as conveyed application for stockpile treatment
- CN8 effectiveness as conveyed application for stockpile treatment
- ET application on stockpiles at room temperature
- ET application on stockpiles at sub-zero temperature
- 829C application on stockpiles at room temperature
- ET effectiveness on treated and then disturbed stockpiles
- 829C effectiveness on treated and then disturbed stockpiles

This study will put on emphasis on comparing results based on cost, rather than dosages. It is obvious that 10% 829C performs better than 10% ET; however, 829C is roughly 3.6 times more expensive than ET. Therefore, this study will assess the performance of ET and 829C using the same “cost dosage”.

Test Methodology

SOP 48 was modified to test the resilience of crusts prepared using Envirobind ET and Envirocrust 829C. Modifications include:

- 50 g piles were prepared and treatment dosage = 0.67 kg/m^2
- Dried Conuma coal (<4.75mm) was used
- Treatments were applied at various concentrations
- Room temperature samples were dried overnight under solar lamps
- Sub-zero temperature samples were left overnight in a -20^{o}C freezer
- Piles were then placed in the wind tunnel set to 40 Hz for 5 minutes

To test the effectiveness of ET and 829C on uneven and disturbed stockpiles, stockpiles were created as usual and then a spoon was used to dig into the stockpile at the 1 o'clock and 5 o'clock positions. The resulting stockpile was then retreated with ET or 829C.

Results and Discussion

ET costs $1.55/kg and 829C costs $5.60/kg. 829C costs 3.6 times more than ET. With this in mind, 1% 829C is compared to 3.6% ET. 3%, 5%, and 10% 829C are compared to 10.8%, 18%, and 36% respectively. Table 1 below compares the two formulations at the same cost dosages. As shown in table 1, 829C performs better than ET at low cost dosages. Increasing the concentration of 829C improves the performance marginally. In contrast, increasing the concentration of ET drastically improves the stockpile retention. At 3.6% ET, the crust created was too weak and the stockpile blew away in the wind tunnel. At 10.8% ET, the crust was strong enough to retain >99% of the stockpile.

Sample	Concentration	% loss	Sample	Concentration	% loss
ET	3.6	97.0	829C	1	5.4
	10.8	0.4		3	5.3
	18	0.0		5	3.2
	36	0.0		10	1.2

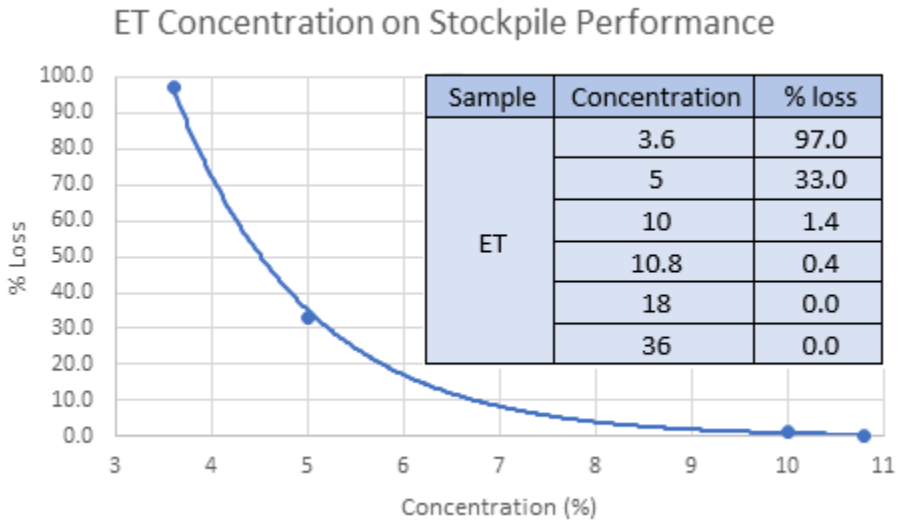
Table 1: Same cost dosage comparison of ET and 829C formulations as stockpile treatments

Refer to the following videos for a quick comparison: ET 3.6%, 829C 1%, Blank. The blank completely blew away within 40 seconds whereas the sample treated with ET 3.6% blew away after 2 minutes. Even at a low concentration of ET, there are still noticeable stockpile retention benefits.

ET forms a thin crust enveloping the entire stockpile surface. In contrast, 829C forms a harder crust with mini holes like swiss cheese. This may be due to the wetting performance difference between the two products. ET wets the surface of coal easier and can spread out evenly whereas 829C does not easily wet the coal surface which leads to a patchier crust, shown in Figure 1. The difference in crust characteristics also explains the minor % loss at high 829C concentrations. Coal can be blown away easier in the patchy areas where the crust did not form. Therefore, the minor % loss associated with 829C may be due to its wetting performance on dry coal. It is important to note that the wetting performance may change on wet coal. If a smooth crust forms from better wetting, it is possible that the stockpile performance would increase.

Figure 1: Stockpile treated with 829C (left). Patchy crust lifted off stockpile (right)
To compare the two crust compositions: 829C Crust Video And ET Crust Video

At lower concentrations, 829C will provide the most value in stockpile performance. However, at higher concentrations such as 10% ET, ET outperforms 829C. Figure 2 below shows an updated analysis on the effects of ET concentration on stockpile performance. There is an exponentially decaying correlation between concentration and performance. Increasing the concentration above 10% provided minimal performance gains. It is important to note that the testing dosage was 0.67kg/m^2. The graph may change according to the dosage but the overall trend should remain constant.

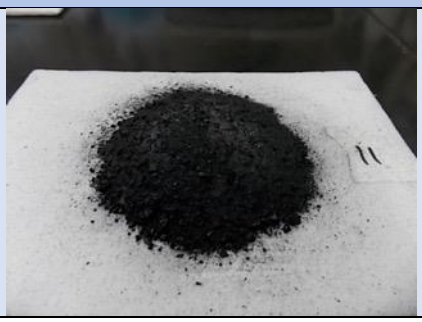
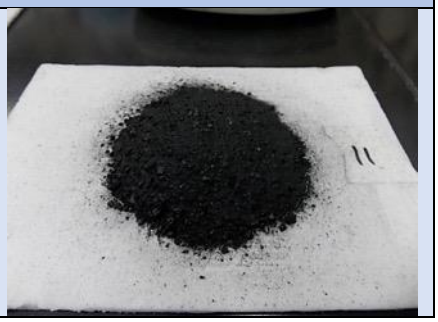


Sample	Concentration	% loss
ET	3.6	97.0
	5	33.0
	10	1.4
	10.8	0.4
	18	0.0
	36	0.0

Figure 2: Effects of ET concentration on stockpile performance

ET was also tested on stockpiles at -20°C. Referring to Table 2 below, 5% and 10% ET treatment was enough to retain >99% of the stockpile. Unlike the stockpiles dried under the solar lamps, sub-zero stockpiles retained their moisture. The extra moisture remaining on the surface of the stockpile acts as an additional weight and adhesive binding the coal together. Therefore, the 5% ET freezing sample had a 0.57% loss whereas the 5% ET room temperature sample had a 33% loss. From this set of tests, ET performs better at sub-zero temperatures.

1. Video: 5% ET sub-zero
2. Video: 10% ET sub-zero

Sample	% loss	Before	After
5% ET -20°C	0.57		

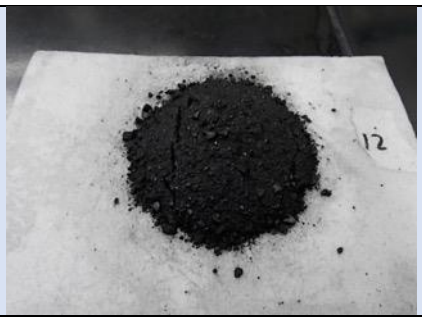
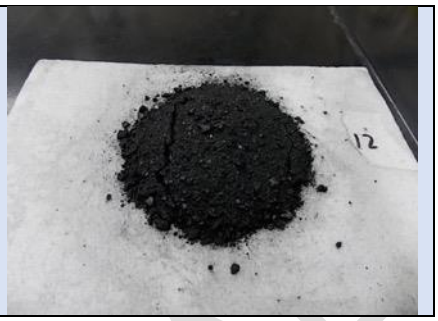
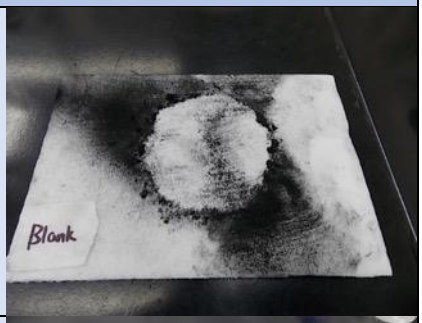
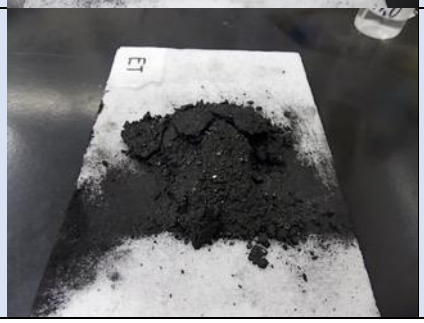
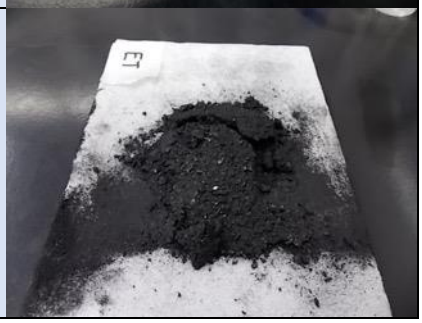
10% ET -20°C	0.97		

Table 2: ET performance at sub-zero temperatures (-20°C)

ET and 829C were also tested on uneven stockpiles. An uneven stockpile is a treated stockpile which is then disturbed as if coal was dug out from the pile.

1. Video: Disturbed stockpile treated with ET
2. Video: In the wind tunnel
3. Video: After wind tunnel crust analysis

Sample	% loss	Before	After
Blank (uneven)	99.3		
ET (uneven)	10.1		

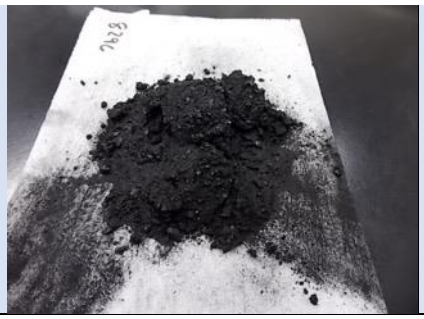
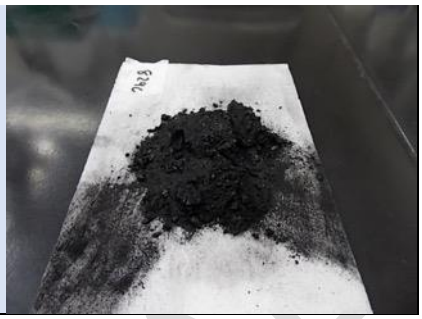
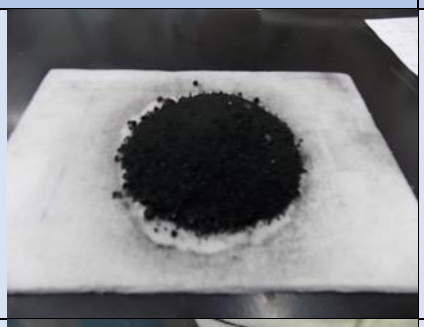
829C (uneven)	2.8		

Table 3: Uneven/disturbed stockpiles retreated and tested in the wind tunnel

In addition to testing ET and 829C, WDS and CN8 effectiveness as conveyed application for stockpile treatment was tested. As requested, the maximum dosage tested was 70ppm. Coal samples were treated with the formulations at 1% and then mixed briefly. The resulting samples were shaped into a conical pile left overnight under the solar lamps. The dried sample was tested the following day in the wind tunnel. As shown in Table 4, WDS and CN8 do not provide any measurable benefit at 70ppm. All samples took approximately the same time to blow away in the wind tunnel. Refer to the videos below:

1. Video: Blank
2. Video: WDS 70ppm
3. Video: CN8 70ppm

Sample	% loss	Before	After
Blank	99.8		
1% WDS	99.8		

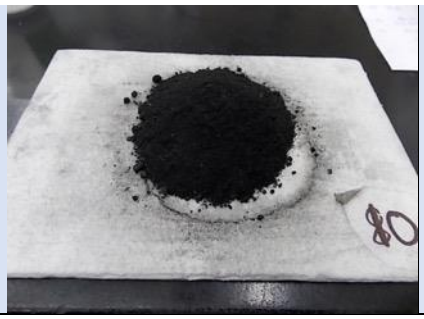
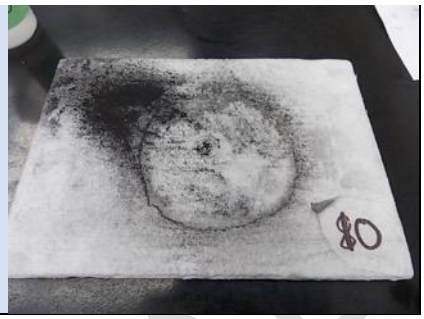
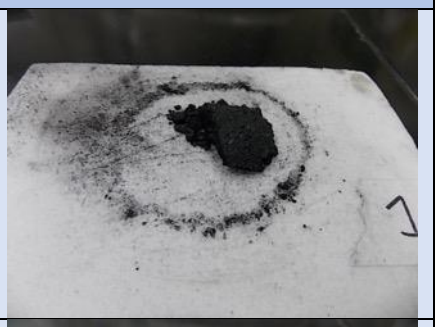
1% CN8	100		

Table 4: WDS and CN8 effectiveness as conveyed application for stockpile treatment

Although WDS and CN8 had no effect on stockpile retention at 70ppm, WDS and CN8 play a role in retaining stockpiles at much higher concentrations. Table 5 below shows that at high dosages (0.67kg/m^2) and high concentrations, WDS and CN8 applications prevent the stockpile from blowing away. Unfortunately, this is not practical in the real world due to costs.

1. Video: 10% WDS High Dosage
2. Video: 50% WDS High Dosage
3. Video: 100% WDS High Dosage
4. Video: 10% CN8 High Dosage
5. Video: 50% CN8 High Dosage
6. Video: 100% CN8 High Dosage

Sample	% loss	Before	After
10% WDS	87.9		
50% WDS	0.2		

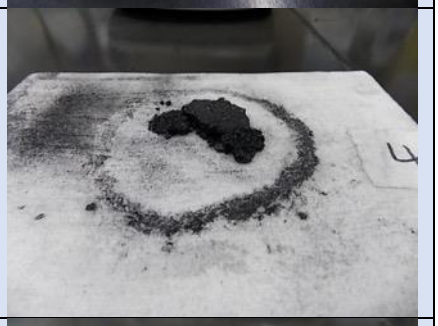
100% WDS	0.1		
10% CN8	90.9		
50% CN8	28.8		
100% CN8	22.0	Missing photo (not taken)	

Table 5: WDS and CN8 at high concentrations and dosages (0.67kg/m^2) as stockpile treatment

Conclusion:

Both ET and 829C are effective stockpile treatments. At the same cost dosage, 829C performs better at low concentrations and ET performs better at higher concentrations. Furthermore, ET performs well at sub-zero temperatures. Both formulations are capable of retreating disturbed stockpiles. Asides from ET and 829C, WDS and CN8 are have no effect on stockpiles at 70ppm. At higher concentrations however, WDS and CN8 provide some stockpile retention but this is impractical due to cost.

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