Use of Fluidized Bed Combustion Ash for Capping of Refuse at the Tygart River Mine

by

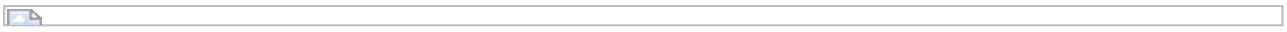
Courtney Black[1]
Bernard H. Voor III, P.E.[2]
Joseph Sweetnich[3]

Introduction

The United States currently has more than 480 billion tons of mineable demonstrated reserve base of coal. Unfortunately coal contains a number of components such as sulfur and nitrogen that form undesirable oxides during combustion. Coal also contains incombustible mineral matter that is converted into ash and leads to suspended particles in the air and degradation of downstream components. Several advanced coal combustion technologies designed to prevent the release of sulfur dioxide and nitrogen oxides have been developed. One such technology, fluidized bed combustion (FBC), produces a large quantity of waste that has a high percentage of free lime or slake lime with a large portion of fly ash. This FBC ash can present a disposal problem. Its high pH can cause landfill costs to be quite high. Another clean coal technology, magnesium enhanced lime wet flue gas desulfurization (thiosorbic process), also produces an alkaline waste product with similar disposal problems. Mining operations have also utilized washing techniques to remove some undesirable materials such as shale and pyrite from the coal before it is sent to the customer. This washing process lowers the sulfur content and increases the B.T.U. value of the coal. The waste produced in this washing process also presents disposal problems due to the acidic nature of the waste.

The paper recycling industry is also faced with a disposal problem. Before paper can be recycled the ink must removed. This deinking process produces a byproduct that contains short paper fibers in a mixture of clays. The byproduct also has a pH of 12 and a calcium carbonate equivalent content of 10 to 21%. Such an alkaline material may create a disposal problem. However, Keefer Paper Company in Indiana has worked with Peabody Holding Company to successfully use the byproduct as a soil amendment to enhance vegetative growth.

Coal mining areas have been subjected to a series of problems. The legacy of coal mining has been acid mine drainage due to dissolved pyrite forming sulfuric acid where abandoned mine workings drain underground water pools. Unreclaimed refuse piles can also produce acid when brought in contact with surface water.



[1]National Mine Land Reclamation Center, West Virginia University, Morgantown, WV

[2]Ogden Environmental and Energy Services, Nashville, TN 37211

[3]Eastern Associated Coal Corp, Charleston, WV 25302

The combined disposal problems of advanced coal combustion byproducts, paper recycling byproducts and acid mine drainage create a ready-made market. The problem of advanced coal combustion byproducts disposal can be solved by using the FBC and FGD material to form a cap over acid producing coal refuse sites. FBC ash, which is highly pozzolanic, will achieve a reasonable compressive strength when water is added and will preclude water from the refuse pile. The neutralizing potential of the material also makes it an ideal candidate for acid mine drainage prevention. FGD material is also alkaline and becomes highly impermeable when allowed to dry. Paper recycling byproducts can then be placed on top of the FBC and/or FGD cap to enhance vegetative growth. This solution carries the multiple benefit of creating a market for the advanced coal combustion byproducts and providing abandoned mine authorities with a new tool to combat abandoned mine land problems. The potential market for the FBC ash, FGD material, and paper deinking byproducts includes every active coal and non-coal surface mine, every abandoned surface mine and refuse site that state and federal agencies are in the process of reclaiming. The potential market is such that future coal contracts may include clauses to back-haul the advanced coal combustion materials to the mine. Full implementation of this application of FBC ash, FGD material and paper deinking byproducts will change them from a waste product to a marketable product. This will encourage power companies and other large and small scale coal burners to make the decision to use advanced coal combustion technologies, and aid the paper recycling industry in solving waste disposal problems through beneficial use of waste materials.

Background and Technical Approach

Eastern Associated Coal Corp. manages the Tygart River Mine in Marion County, West Virginia for Martinka Coal Company. The mine site is coupled with a refuse facility that have both been idle since the mine suspended operations in the fall of 1995. Two refuse piles exist on the property, Sand Bank Pile and Levels Road Pile. The plan for the project is to reclaim the Sand Bank Refuse Pile by capping it with a combination of alkaline waste products. The first product to be investigated is FBC Ash from the Grant Town Power Station. Other products to be investigated include a Paper Deinking Byproduct from the newly opened paper recycling facility in Fairmont, WV, and lime-fly ash stabilized FGD solids from the Harrison Power Plant.

To effectively evaluate the materials, a bench and pilot-scale testing program was devised. The program began with acid/base account analysis on all materials. A Toxicity Characteristic Leaching Procedure (TCLP) was also performed for all materials. Standard Method 1311 (pH 4.0 acetic acid) was used for the TCLP. A more acidic leaching solution (pH 2.5 sulfuric acid) was used to increase the effectiveness of this test. The more aggressive solution was used to try and overcome the highly alkaline nature of the products. The metals analysis was determined from the WV DEP's Ash Utilization Policy and the researchers' past experience with the materials. To date, both the FBC ash and FGD material have been tested.

The geotechnical properties of the FGD material determined that it will be used in a blend with refuse if used in the cap. A column leach test was initiated for the FGD material and

refuse blend. The materials were blended by weight on a ratio dependent upon NP/MPA. To date, work has not been initiated by the team on the paper deinking byproduct.

On a pilot scale, two test piles containing a blend of FBC ash and refuse have been constructed and monitored since the Summer of 1995. Both piles were constructed on top of a plastic liner and contain pan lysimeters to collect water samples. The design of the piles will be displayed in the presentation.

Results & Discussion

Table 1 displays the results of the TCLP test performed on the FBC ash from the Grant Town Power Station. The test was performed with three solvents (AMD, H_2SO_4, and Method 1311 Fluid) in duplicate. The final values for pH of all solutions were high (11.7 to 12). No acidity was present after the leach and alkalinity values were high. Concentrations of metals were low with many below detectable limits for the Inductively Coupled Plasma techniques used in the analysis. The results of the TCLP for the FGD material are not displayed as all metal concentrations were below detectable limits for the same ICP methods. Data from the column leach experiments will be presented but are not available at the time of this writing.

Table 2 contains water quality data from a pond that receives water from the Levels Road Refuse pile. This sampling point is being used as a control for the test pile data. Table 3 and 4 contain data from the two test piles. The pH of the effluent from the test piles has been above neutral except for the February sample. Metal concentrations are low but the alkalinity never exceeds 64 ppm.

One possible explanation for the performance of the test piles is their construction. When the test piles were constructed, the Tygart river Mine was operating and producing refuse daily. The FBC ash was to be used in a daily blend with refuse in the structural zone (120 feet from toe of slope) of the pile. The primary use of the ash was to add stability to the structural zone. A secondary benefit was improvements in water quality. The piles were constructed to assure the WV Division of Environmental Protection that no metals would leach from the ash when placed in the acidic environment of the pile. The idea for a cap was to be examined at a later date when the Sand Bank Pile would be reclaimed. Now that the mine has went on suspension, the capping concept is being pursued for the Sand Bank Pile. Experiments are underway to determine the optimal blend of FBC ash, FGD material, paper deinking byproducts and top soil to be used in the cap. If available, data from these experiments will be presented.

Table 1 Fluidized Bed Combustion Ash TCLP Data

National Research Center For Coal And Energy
Analytical Laboratory
P.O. Box 6064, Evansdale Drive
Morgantown, WV 26506-6064

phone 304-293-2867

Date Dec 1995

	Sample ID	pH	Conductivit umhos/cm	Alkalinity mg/l CaCO3 eq	Fe mg/l	Mn mg/l	Al mg/l	Ca mg/l	Mg mg/l	SO4 mg/l	As mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Ni mg/l	Se mg/l	Tl mg/l	Zn mg/l	B mg/l	Ba mg/l	Cr mg/l	Hg mg/l
	***Method Used** **	*SM4500-H*	*SM2510*	*SM2320*	*SM3111B*	*SM3111B*	*SM3111D*	*SM3111*	*SM3111*	*SW9038*	SM3111	SM3113	SM3113	SM3113	SM3113	SM3113	SM3111	SM3113	SM3113	SM3113	SM3113	SM3113
1	Granttown AMD	11.7	4550	725 6	0.23	< 05	0.41	1007	0.46	1518	< 05	< 05	0.12	0 05	< 05	0 1	0.15	<.05	<.05	0.19	<.05	<.05
2	Granttown Ash AMD	11.8	5950	1078	0.06	<.05	0.49	1153	0.47	1555	0.08	<.05	0.09	0.12	0.06	0.1	0.14	<.05	0.05	0.2	<.05	<.05
1	Granttown Ash pH <2 0	12	8200	2451	< 05	<.05	0 49	1753	0.47	1768	0.09	<.05	0.09	0.12	0.05	0.13	0.13	<.05	< 05	0 25	0.05	<.05
2	Granttown pH<2 0	12	9700	2429	<.05	<.05	0.53	1771	0.48	1778	0.08	<.05	0.1	0.15	0.07	0.17	0,06	<.05	0.05	0.25	0.06	<.05
1	Granttown Ash pH 4 0	11.8	9330	4150	0.05	<.05	0.63	3067	0.49	1151	0.24	< 05	0.12	0.17	0.08	0.1	0.08	<.05	0.06	0.34	<.05	0.08
2	Granttown pH 4 0	11.8	8920	4360	0.07	<.05	0.57	2988	0.48	1265	0.23	<.05	0.13	0.18	0.08	0.14	0.21	<.05	0.07	0.34	0.05	<.05
	AMD Blank				671	4.7	159	402	166	4167	1.76	< 05	0.06	0.68	1.37	1.37	2.34	2.82	0.62	< 05	0.19	0.36
	H2SO4 Blank					<.05	<.05	<.05	<.05	438	<.05	< 05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	1311 Fluid Blank					<.05	< 05	< 05	< 05	<9.6	0.07	< 05	< 05	<.05	<.05	< 05	< 05	<.05	<.05	<.05	<.05	<.05

* Standard Methods For The Examination Of Water and Wastewater 18th Edition - American Public Health Association, American Water Works Association, & Water Pollution Control Federation, 1992

Table 2 Water Quality Data from Pond 5

Analyte	Feb 95	March 95	April 95	May 95	June 95	July 95	Aug 95	Sept 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96
pH	2.70	2.60	2.50	2.50	2.60	2.50	2.50	2.40	2.50	2.50	2.60		2.60
Total Acidity (hot)	2350	814		1490	2720	3170	1400	3400	3400	4260	410		2150.00
Mineral Acidity	694	515		922	1640	1880	186	2070	1840	2190	2070		998.00
Alkalinity	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1		<1
Total Iron	808	220		536	885	886	770	1010	892	1160	1190		692
Total Manganese	37	13		14	22	33	22	55	42	37	37		29.80
TSS	128	10		7	7	88	58	61	39	56	11		13.00
TDS	5068	2073		3671	4974	7840	5537	8032	6979	5218	7022		5211.00
Spec Cond		6640		8100	8120	34700	8070	22100	7980	8270	8140		6890.00
Sulfate	3050	1260		2330	3340	62000	3070	4900	4040	3980	4250		3500.00
Al	82	27		47	77	110	121	135	179		138		84.00
Ca		266		325	209	392	342		309	339	322		409.00
Se	0	0		0	0	0	0	0	0	0	0		0.031

Table 3 Water Quality Data from Pile 1

Analyte	Aug 95	Sept 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96
pH	7.52	7.80	7.5	7.50	7.30		6.60
Total Acidity (hot)	161	<1	<1	19	<1		<1
Mineral Acidity		0			0		0.00
Alkalinity	44	38	33	33	31		35.00
Total Iron	<.5	0	<.5	<.5	<.05		3.78
Total Manganese	1	0	5	5	17		3.12
TSS		1			1		8.00
TDS					3511		
Spec Cond	2700	3220			4980		4540.00
Sulfate	1150	1080	2210	2450	2260		2030.00
Al	1	0	<0.5	<.5	<.1		0.76
Ca	418	412	632	640	575		532.00
Se					0.017		0.147

Table 4 Water Quality Data from Pile 2

Analyte	Aug 95	Sept 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96
pH	7.46	7.90	7.40	7.30	7.40		6.40
Total Acidity (hot)	<0	<1	0	<1	<1		<1
Mineral Acidity	0	0	0	0	0		0.00
Alkalinity	53	47	64	30	36		22.00
Total Iron	1	0	<0.5	0	0		1.99
Total Manganese	<.15	<.01	<0.5	12	1		3.08
TSS		2		21	1		6.00
TDS					3125		
Spec Cond	2860	990		5030	460		4310.00
Sulfate	1580	418	2100	2260	2190		1990.00
Al	1	0	<0.5	2	<.1		0.86
Ca	589	183	690	649	633		567.00
Se					0.011		0.048