WEATHERING BEHAVIOR OF OVERBURDEN-COAL ASH BLENDING IN RELATION TO OVERBURDEN MANAGEMENT FOR ACID MINE DRAINAGE PREVENTION IN COAL SURFACE MINE

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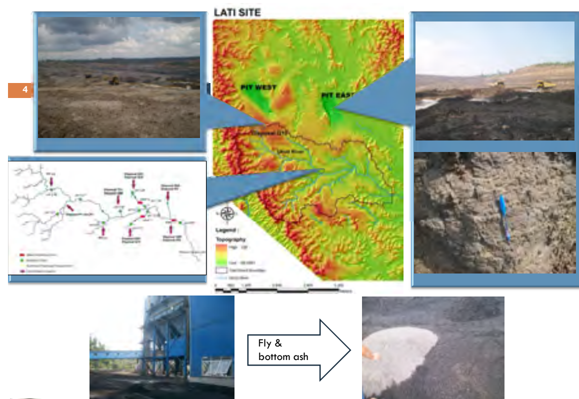
Introduction

- Indonesia is the 2nd largest coal exporter in the world
- Total annual production 250 million tonnes
- More than 50 coal mines (small to large scale)
- The annual production of PT Berau Coal: 15 million tonnes

Introduction

- Lati coal mine (PT Berau Coal) – located in East Kalimantan, Indonesia - is suffering from AMD problem since most of the overburden as well as interburden material is classified as potentially acid forming.
- The deficit on non-acid forming material leads to the attempt to investigate the alternatives in AMD mitigation, one of which is the use of coal combustion (fly and bottom) ash from the nearby coal fired power plant.
- Due to the Indonesian regulation, coal combustion ash is classified as a hazardous waste. It is, however, encouraged to re-use the ash rather than conserve and dump the ash as a waste.
- The aim is to study the various blending schemes of overburden and coal combustion ash in preventing the AMD generation



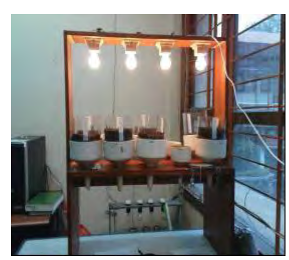
Materials & Methods

- Samples:
  - Overburden samples were taken both from the mine pit (FR) and the waste dump (OB).
  - Fly ash (FA) and bottom ash (BA) were collected from the ash disposal in the power plant.
  - Mineral composition was identified using XRD analysis and the major chemical composition analyzed by XRF
  - Static test was conducted to characterize the samples; geochemical rock type was defined by using acid-base accounting calculation and NAG test result

Materials & Methods

Methods

- Free draining column leach test, daily flushing with deionized water
- During flushing, infiltration rate was measured
- Daily measurement of leachate: pH, EC, TDS
- Metal content analyzed form bi-weekly cummulative leachates



Mixing/Blending scheme

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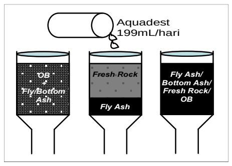
Table 3. Composition of Samples for Testing (in %)

Sample	Blending				Layering			Control			
	$BA_{30\%}$	$BA_{20\%}$	$FA_{30\%}$	$FA_{20\%}$	$FA_{30\%}$	$FA_{20\%}$	$FA_{10\%}$	BA	FA	OB	FR
Fly Ash	-	-	30	20	30	20	10	100			
Bottom Ash	30	20	-	-	-	-	-		100		
OB	70	80	70	80	-	-	-	-	-	100	
FR	-	-	-	-	70	80	90	-	-	-	100
Total	100	100	100	100	100	100	100	100	100	100	100



Major chemical composition and static test result

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	Major Chemical Composition (%)											
	SiO_2	CaO	Fe_2O_3	Na_2O	AL_2O_3	MgO	K_2O	TiO_2	MnO	P_2O_5	SO_3	LOI
Fly Ash	19.68	15.00	12.77	10.95	8.72	3.02	0.93	0.50	0.10	0.09	22.64	5.18
Bottom Ash	16.11	17.56	26.47	4.53	7.09	2.99	0.78	0.67	0.16	0.07	10.42	12.27
OB	55.88	0.88	7.07	0.73	15.71	1.46	1.68	0.64	0.10	0.05	0.23	15.21
Fresh Rock	58.92	0.43	5.02	1.28	16.11	0.94	1.60	0.62	0.07	0.11	0.34	14.08

No	Sample	Paste pH	Tot. Sulfur*)	ANC**)	NAPP**)	NAG pH	NAG**) pH4.5	NAG**) pH7
1	Fly Ash (FA)	11.87	5.60	86.46	84.90	9.70	-	-
2	Bottom Ash (BA)	9.21	1.71	51.52	0.81	5.90	-	2.37
3	Overburden (OB)	3.14	1.92	59.22	-0.47	3.00	8.29	16.58
4	Fresh Rock (FR)	4.54	1.94	0	59.36	2.47	28.42	40.56

Note : *) = in %; **) = in Kg H_2SO_4/ton ; ANC = Acid Neutralizing Capacity; NAPP = Nett Acid Producing Potential; NAG = Net Acid Generation

Results & Discussion

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Physical Characteristics & Permeability

The weathering process was influenced by the fluctuations of temperature and humidity and the flushing frequency. It could be visually observed in the form of physical changes of samples during the time of the simulation. The significant visual changes were the reduction of grain size and the change in color from dark brown to brown

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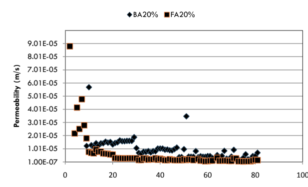
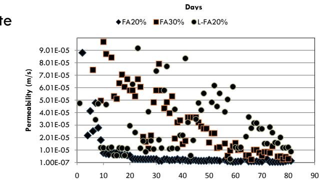
Since the permeability in control columns that consisted of 100% fly ash and bottom ash did not show any significant change → the decrease in the permeability might be resulted from the weathering of rock materials.



Larger decreasing infiltration rate occurred in the fly ash blending columns compared to that in the bottom ash blending columns



It could be important in improving the performance of capping in the encapsulation of PAF material.

pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS)

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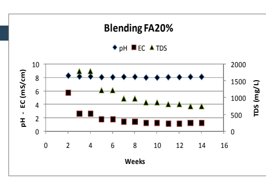
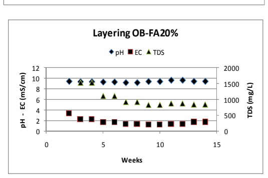
- 14 weeks simulation
- The pH, EC & TDS values in the fly ash blending column was higher than that in the bottom ash blending but still lower than that in the layering column.



- The alkalinity of fly ash was more reactive and stable than bottom ash and more effective in neutralizing the acid.
- The layering mix of fly ash showed higher pH values meaning higher neutralizing performance.



Metal Content

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- The metal content was analyzed from bi-weekly cumulative leachates collected for each column.
- Higher metal content in fly ash than in bottom ash and in fresh rock
- A higher metal content in the layering scheme might be caused by the AMD that was already generated in the rock sample prior to its neutralization during infiltration in the layer of fly ash

	Fe (mg/L)			Mn (mg/L)			SO_4^{2-} (mg/L)			Cu (mg/L)			Zn (mg/L)		
	Max	Min	Avrg	Max	Min	Avrg	Max	Min	Avrg	Max	Min	Avrg	Max	Min	Avrg
BA	4.89	0.22	1.52	25.04	2.30	8.98	2,629	135	1,532	0.14	0.03	0.07	2.21	0.02	0.90
FA	459.40	0.04	139.91	139.70	0.11	33.83	16,475	112	5,146	0.53	0.00	0.26	2.65	0.01	1.10
FR	54.40	4.12	32.60	81.50	1.77	29.01	5,003	245	2,274	13.43	0.91	6.52	7.26	0.49	2.92
OB	5.69	0.44	2.61	22.05	0.69	8.13	1,279	208	679	4.48	0.38	1.60	2.90	0.38	1.52
Blend-BA30%	1.03	0.04	0.49	27.23	1.76	10.26	7,491	285	2,322	0.38	0.00	0.08	2.13	0.05	0.45
Blend-BA20%	0.99	0.12	0.56	30.72	0.60	15.66	12,295	132	3,213	0.08	0.00	0.02	0.30	0.02	0.10
Blend-FA30%	0.78	0.39	0.57	0.60	0.01	0.30	33,575	41	6,412	0.13	0.01	0.04	0.08	0.02	0.04
Blend-FA20%	0.56	0.02	0.29	11.65	1.02	6.34	21,610	130	5,068	0.07	0.00	0.02	0.05	0.00	0.03
Lay- FR-FA30%	6.10	0.02	2.16	5.90	0.03	1.55	23,860	559	5,946	0.20	0.01	0.06	0.41	0.02	0.10
Lay- FR-FA20%	30.50	0.03	8.58	11.32	0.46	6.14	17,545	772	5,232	0.18	0.01	0.07	0.80	0.02	0.26
Lay- FR-FA10%	0.55	0.04	0.26	1.39	0.31	0.85	13,470	101	2,997	0.04	0.00	0.02	0.05	0.01	0.03

Conclusion

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- Bench scale simulations using rock and coal combustion samples with different mixing schemes have been conducted to study the weathering process of rock samples
- The change of permeability relative to time occured due to the rock particle size reduction. In the blending columns the permeability decreased more significantly compared to that in the layering columns. The fly ash blending, due to a smaller grain size, gave lower permeability than the bottom ash.
- The effectiveness of rock sample weathering in controlling the neutralization of AMD was measured in the quality of leachates in term of pH, electrical conductivity, total dissolved solids and chemical composition.

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Conclusion

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- Overall, it could be concluded that overburden blending with coal combustion ashes, particularly fly ash, has the potential to prevent AMD generation in the disposal area, especially for Lati Coal Mine
- Follow up studies are necessary to make it applicable in the mining operation.

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