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Characteristics of Acid Mine Water

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Abstract : This study aims to investigate the characteristics of acid mine water from the water layer inside one of the existing voids in the coal mine site will be passive processing performed by using water as a medium phytoremediasi plants. Shingga be known acidity and heavy metal content of the surface layer, colloid (float), as well as sediment. Expected later found that plant species used as media bias wetlands in accordance with the characteristics of acid mine drainage in the area tersebut.Hasil showed the characteristics of each layer of the water into the acid mine water is different. More precipitate containing heavy metals Fe, Mn deposition is proportional to the number of parameters TSS . Result analysis show that characteristics of acid mine water at 4 void on the bottom layer (sludge) contains more heavy metals than the type of Fe and Mn in the middle layer (colloidal) and upper layer (surface), namely : 0.97-1,97 ppm for Fe and 12.12 to 12.40 ppm for Mn . But to the degree of acidity / pH on the third layer is more or less the same at the rate of 3:03 to 3.04 ppm. Especially for Void M2W was found that the water quality parameters of pH for the better in depth . Fe and TSS increasingly lower quality in comparison to the surface, except for Mn lower water quality in the middle / drift - colloid (50 - 75 cm) compared with the inside and the surface (25 cm and 100 cm). Recommended for the management of acid mine drainage passive phytoremediation method chosen variations in root crops , drift and surface in order to reduce heavy metals from acid mine drainage each layer .

Keywords: acid mine drainage, acid mine drainage characteristics, passive management, phytoremediation, heavy metals.

Introduction

Acid mine drainage (Acid Mine Drainage) derived from coal mining, which causes changes in soil layers resulting in oxidation of iron sulfide/ pyrite (FeS_2) with water (H_2O) and oxygen (O2) that cause acid mine drainage (H_2SO_4) both organic and inorganic reactions[1]. Prevention of formation of acid mine drainage can be by way of inhibiting the meeting between pyrit, oxygen and water at a time. The process of formation of AMD is generally represented by the following reaction, four chemical reactions below describes the oxidation of pyrite and subsequent conversion [2]:

Reaction 1: $2\ FeS_2 + 15\ O_2 + 2\ H_2O \rightarrow$
$2\ Fe^{2+} + 4\ SO_4^{2-} + 4\ H^+$
Reaction 2:$4\ Fe^{2+} + O_2 + 4\ H^+ \rightarrow$
$4\ Fe^{3+} + 2\ H_2O$
Reaction 3:$4\ Fe^{3+} + 12\ H_2O \rightarrow$
$4\ Fe(OH)_3 + 12\ H$
Reaction 4: $FeS_2 + 14\ Fe^{3+} + 8\ H_2O \rightarrow$
$15\ Fe^{2+} + 2\ SO_4^{2-} + 16\ H^+$
Thiobacillus Ferroxidans

This process begins with the oxidation of pyrite and release of ferrous iron (Fe^{2+}), sulfate, and acidity (Equation 1). Sulfide-oxidation process is accelerated by the presence of Thiobacillus bacteria. Then oxidize ferrous iron, ferric iron form (Fe^{3+}) (Equation 2). Finally, Fe^{3+} reacts with H_2O (hydrolyzed), forming insoluble iron hydroxide ($Fe(OH)_3$), an orange precipitate, which releases additional acidity (Equation 3). $Fe(OH)_3$ formation process depends on pH, and happen quickly when pH <4 [1]. In the formation of acid mine drainage, there are types of iron oxidizing bacteria Thiobacillus ferrooxidans can accelerate the oxidation of iron and formation of acids [3] which became Catalysis Biotic so that increases the formation of acid up to one million times [4].
Acid mine water treatment in the United States starting from 1977 by using active methods with various chemicals [5] with a great cost. To reduce the high cost of processing the passive treatment with a variety of methods were developed)[6]. This method also has other advantages, namely: Cheaper, does not require mechanical devices, hazardous chemicals and building, requiring no electricity, operation and maintenance is not every day, more natural to the environment and help the growth of plants and the ecosystem around it[7]. Aerobic wetlands or wetland management requires the main thing is: Plant as a recovery agent polluted environment[8]. Plants can also be as hiperakumulator heavy metals that have the ability to concentrate metals in unusually high levels in the following terms: 1). Accumulation rate should be high even at low environmental levels of contaminants, 2). Ability to accumulate high levels of contaminants. 3). Ability to accumulate various kinds of heavy metals. 4). Grow fast, 5). High biomass production, 6). Resistant to pests and diseases. Some water plants and many species are able to accumulate metals in heavy metal contaminated waters [9].Acid mine drainage treatment in coal mining companies in Indonesia generally and in particular in South Kalimantan are still using active methods using chemicals quicklime ($CaCO_3$) for easy use in the field. Passive methods are still little developed one pertambangaan coal companies namely Berau Coal in East Kalimantan, which has been using the SAPS (the successive alkalinity producing systems) [10].This study aims to investigate the characteristics of acid mine water from the water layer inside one of the existing voids in the coal mine site will be passive processing performed by using water as a medium phytoremediasi plants. Shingga be known acidity and heavy metal content of the surface layer, colloid (float), as well as sediment. Expected later found that plant species used as media bias wetlands in accordance with the characteristics of acid mine drainage in the area.

Materials and Method

This study used a sampling method in 4 areas namely void Void-M45, M23-Void, Void-M2W, Void M4E in the coal mining company PT.Jorong Barutama Greston in July-August 2012, which is located in District Jorong, Kabupaten Tanah Laut, Province South Kalimantan - Indonesia, which is depicted in Figure 1.

Figure 1. Research Location.

Acid mine water samples by means of vertical water sampling is depicted in Figure 2, consists of 3 parts depths (surface, middle, base) with the sampling process as in Figure 3.

Figure 2.Vertical water sampling tool.

Figure 3. The process of water sampling in acid M2W void.

Quality of the water quality monitoring was conducted in the laboratory of acid mine water acid mine PT.Jorong Barutama Greston for the parameters pH and Heavy Metal Fe and Mn using a Horiba pH meter brands, HACH-DR 2800 Spectrophotometer for measuring metals Fe and Mn, beakers, distilled water, ferrous reagent (Cat No.1037-69) and manganese reagent (Cat No.24300-00) in Figure 4.

Figure 4. Process Parameter Analysis Acid Mine Water in the Laboratory.

Data Analysis Method

Analysis of data using graphs and comparing the degree of acidity (pH) and Fe and Mn for each layer of acid mine water and its relation to water quality standards according to the prevailing regulations of the department of environmental water used for mining by the decision of the Governor of South Kalimantan 36 of 2008 in Appendix 132: Raw wastewater quality mining, processing / coal washing as outlined in Appendix 8[11].

Result

Research that has been conducted in four locations Acid Mine Water Swimming Shelter former coal mining, which are inactive / void in PT.Jorong Barutama Greston during the month of September 2012 is located in the District Jorong, Kabupaten Tanah Laut, South Kalimantan Province - Indonesia. Location void conducted research are: Void-M45, M23-Void, Void-M2W, Void M4E are depicted in Table 1.

Table 1. Characteristics of acid mine drainage from 4 Void.

3 Criteria Point of Sampling													
No	Location	Surface				Middle/ Colloid				Bottom/ Sedimentation			
		pH	Fe	Mn	TSS	pH	Fe	Mn	TSS	pH	Fe	Mn	TSS
		7	7	4	200	7	7	4	200	7	7	4	200
1	Void - M45	**2.54**	3.00	**27.1**	17	**2.54**	2.54	**27**	**22**	2.53	2.54	**27.2**	**69**
3	Void - M23	**2.83**	0.67	**10.30**	2	**2.81**	1.09	**10.85**	**199**	2.77	3.44	**11.40**	**423**
2	Void - M2W	**3.39**	0.17	**11.63**	1	**3.41**	0.42	**8.73**	**144**	3.49	1.27	**10.70**	**333**
4	Void - M4E	**3.35**	0.04	1.7	47	**3.39**	0.03	1.9	**56**	3.35	0.61	4.3	**542**
	Average	**3.03**	**0.97**	**12.68**	**17**	**3.04**	**1.02**	**12.12**	**105**	**3.03**	**1.97**	**13.40**	**342**

Characteristics seen here are the physical and chemical properties of acid mine water sample with 3 kinds of criteria, namely: Surfaces, Colloids / Middle, and sedimentation. Compare the results obtained in the standard premises of Decree of the Governor of South Kalimantan 36 in 2008 with the parameters: pH, Fe, Mn, TSS. in graphik 26-29. sample pH of 4 is void: 3.03 - 3.04 7 exceeds standards, and for Fe 0.97 - 1.97 meets the standards of <7 while for Mn 12:12 to 13:40 exceed the standard> 4 and 342 weeks to TSS in sediment exceeding standards> 200.

Discussion

Characteristics of research results for 4 acid mine water from coal mined voids in the results obtained in Table 2.

Table 2. Characteristics of acid mine drainage on average 4 based on the depth of the void.

No	Parameter	Average from 4 Void				Water Volume (m^3)
		pH	Fe	Mn	TSS	
	Standard	7.00	7	4	200	
1	Surface	3.03	0.97	12.68	17	1,188,917
2	Middle/ Colloid	3.04	1.02	12.12	105	475,219
3	**Bottom/ Sedimentation**	**3.03**	**1.97**	**13.40**	**342**	105,204

Samples were separated into 3 parts, namely the sample surface, colloid and sedimentation to determine the characteristics of each of the acidic water in each layer so that it can later be determined that the most suitable processing model according to the characteristics obtained. Of the four characteristics used in the measurement, namely: pH, Fe, Mn and TSS when compared with standard results obtained mean that acid acid mine water conditions are still very acidic pH <4.5, Fe does not exceed the average quality standard of <7 ppm and Mn exceeded the quality standard for> 4 ppm, while the average TSS in sediment exceeded the quality standard. Especially for Mn can shown that more than on bottom/ sedimentation as in Figure 3.

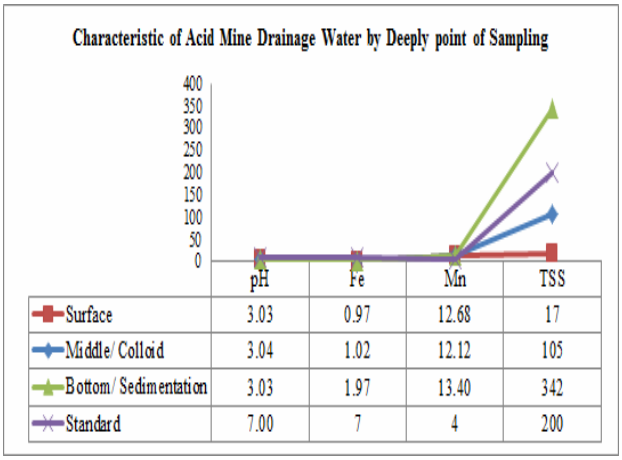

Figure 3. Graph Characteristics of acid mine drainage from 4 voids based samples compared to standard criteria.

Water quality standards in acid mine the overall average obtained results in sedimentation lower compared with colloid / hovering or on the surface. This is because all the material had to settle and accumulate in sediment, could subsequently chosen method of management of acid mine water using passive manner by the method of phytoremediation with plants rooted in water, float and arise on the surface so that it can reduce metals from acid mine drainage.

Conclusions

The research can be concluded that the characteristics of acid mine drainage as follows :

1 . Characteristics of acid mine water at 4 void on the bottom layer (sludge) contains more heavy metals than the type of Fe and Mn in the middle layer (colloidal) and upper layer (surface) , namely : 0.97-1,97 ppm for

Fe and 12.12 to 12.40 ppm for Mn . But to the degree of acidity / pH on the third layer is more or less the same at the rate of 3.03 to 3.04 .

2 . Especially for Void M2W was found that the water quality parameters of pH for the better in depth, sedangakn Fe, TSS increasingly lower quality in comparison to the surface , except for Mn lower water quality in the middle / drift - colloid (50 -75 cm) compared with the inside and the surface (25 cm and 100 cm) .

3. Recomendation for the management of acid mine drainage passive phytoremediation method chosen variations in root crops , drift and surface in order to reduce heavy metals from acid mine drainage each layer .

4. Suggested research needs to be continued for the management of passive acid mine water by using plants according to their characteristics with acid mine drainage. Required 3 different types of plants to reduce the metals that are in each layer of acid mine water depth for optimal results.

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11. Regional Environmental Impact Management Agency of South Kalimantan Province, 2008, South Kalimantan gubernatorial Nomor.036, 2008 132 Appendix: Raw water quality of mining waste, BLHD South Kalimantan.

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