Decreasing level of heavy metals Fe and Mn use the wetland method at coal open mining PT Bukit Asam South Sumatra Province

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Abstract. PT. Bukit Asam, Tbk is a coal mining company that directly produces waste water. For this reason, it is necessary to treat wastewater to neutralize substances that pollute the wastewater, one of the methods used is constructed wetland. The method used is descriptive quantitative method. Where this study will produce the influence of the constructed wetland method in neutralizing waste water from the coal mining process at PT. Bukit Asam, Tbk. Based on the results of the study it can be seen that the waste treatment caused by the Constructed Wetland coal mining process can increase the Ph value from 3 samples averaging 2.6 mg / l, reducing the Fe metal content from 3 samples averaging 9.98 mg / l, and lowering the metal content of Mn from 3 samples averaging 0.75 mg / l and decreasing the level of Total Suspended Solid from 3 samples averaging 486 mg / l. The constructed wetland method that has been implemented at PT. BA has succeeded in neutralizing Fe and Mn metals and TSS according to the standard quality values that meet the standards set by the government.

1. Introduction
Mining is an activity utilizing minerals and coal so that it can be used to meet human needs, one of the industries that supply domestic and foreign energy needs is coal mining. Coal is widely used in various industries including electricity generation, steel industry, space heating and others, in its production activities the industry requires a lot of coal as raw material, in order to fulfill this, Indonesia is one of the largest coal producing countries in the world, to meet the needs Indonesian and foreign coal must implement good mining practices, in fact the coal mining process in Indonesia is generally still not optimal in the implementation of good mining practices, one of the things that are still largely ignored by coal mining companies, namely the problem of handling wastewater into the environment outside the mine [1].

For waste water management, the government has implemented a standard for wastewater treatment, which is based on the environment minister's decree number 113 of 2003, that every mining business is obliged to process wastewater, so that the quality of wastewater discharged into the receiving environment does not exceed the standard quality of wastewater determined.

The wastewater produced from mining activities is called mine acid water, the waste contains iron metal, manganese and high turbidity levels which can pollute river water, and can be resistant to
humans and living things that use the river's functions [2]. "High levels of metal Fe can affect water quality including causing reddish-brown water to smell and cause crusting in the piping system".

Therefore PT. Bukit Asam Tbk. Tanjung Enim Mining Unit needs to conduct acid mine drainage treatment before being channeled to the receiving river. In processing PT. Bukit Asam Tbk. perform processing of acid mine drainage in two ways, namely by active treatment and passively treatment, the treatment system is in active treatment using chemicals in the form of cursive, quicklime and pH adjuster (NaOH solution), and for processing in a passive treatment using constructed wetland methods (artificial wetlands), this method is applied by using water plants that can increase pH, reduce TSS, and absorb heavy metals, especially Fe and Mn in waste water produced from coal mining, to meet environmental quality standards contained in the Minister of Environment Decree Number 113 of 2003, and the Governor of South Sumatra Number 8 of 2012.

2. Materials and Methods
This research is descriptive quantitative research. The purpose of this study was to provide an overview of the effects of the constructed wetland method in neutralizing coal mining wastewater. In this study, to analyze the increase in pH value, decrease in Fe metal content, Mn metal content and suspended residues in acid mine drainage, laboratory tests were carried out and the data were analyzed and compared with wastewater quality standards according to Minister of Environment Decree No.113 2003 and the Governor of South Sumatra Regulation No. 8 of 2012. In this study, samples were taken of each pool in the Stockpile 1 mud settling pond, sampling of each pool was carried out three times with a span of 1 week.

| No | Parameter                  | Unit | Quality Standard |
|----|----------------------------|------|------------------|
| 1  | Iron (Fe) Total            | Mg/L | 7                |
| 2  | Manganese (Mn) Total       | Mg/L | 4                |

Reference: Governor of South Sumatra No. 8 of 2012

3. Results and Discussion
3.1. Change in pH Value
Constructed wetlands can reduce pH values from 5.89 to 6.21 in the first week, 5.11 to 6.33 in the second week and 4.86 to 6.44 in the third week, the following can be seen in the graph.

![PH value graph](image)

**Figure 1. Graph PH value**

For the research of metal content is the same as the research for pH value where sampling is done three times with a distance of one week.
3.2. Change in value of Fe
The effect of Constructed Wetland can reduce dissolved metal Fe in mine acid water waste from 10.215 mg / l to 0.5025 mg / l in the first week, and 9.3272 mg / l to 0.6572 mg / l in the second week, and 12.3122 mg / l to 0.621 mg / l in the third week, the following can be seen in the figure image.

3.3. Change in the value of Mn
For the study of metal content the same as the research for pH and Fe values where sampling was done three times with a distance of one week, from the results of the study found the effect of Constructed Wetland can reduce dissolved Mn metal content in mine acid water waste from 0.8586 mg / l to 0.1512 mg / l in the first week, and 0.7735 to 0.1165 mg / l in the second week, and 1.0023 to 0.1516 mg / l at the third week, the following can be seen in the figure.

3.4. Change in TSS value
For the study of metal content the same as the research for the value of pH, Fe and Mn where sampling was done three times with a distance of one week, from the results of the study found the effect of Constructed Wetland can reduce TSS levels in mine acid water waste from 405 mg / l to 3 mg / l in the first week, and 443 mg / l to 6 mg / l in the second week, and 621 mg / l to 4 mg / l at the third week, the following can be seen in the figure.
3.5. **Effect of water plants on pH values**

According to Arroyo [3] study that aquatic plants can increase pH values from low to high, this is caused by:

1. The content of alkalinity of compost used as a wetland matrix, because the compost can increase the growth of sulfate reducing bacteria which can increase alkalinity, and then can increase the pH value.
2. Interaction of aquatic plants with the surrounding environment, the presence of aquatic plants floating in the pond causes anaerobic environment under the pond, then the water plants carry out photosynthesis by taking CO2, due to the taking of the CO2 by plants so that the pH value of the water increases.

From the results of testing by mardaniyah the average pH increase caused by aquatic plants is 35%

3.6. **Effect of aquatic plants on Fe and Mn levels**

Based on Prihatini [4] study that water plants can reduce levels of Fe and Mn, this is caused by:

1. Interaction between sulfides ($S^{2-}$) produced in the process of reducing sulfates with valent metals 2 (such as $Fe^{2+}$ and $Mn^{2+}$) forming precipitated metal sulphides.
2. The process of metal absorption by plant tissue
3. The process of adsorbing metals by organic materials
4. The process of metal biosorption by microorganisms found in wetland environments

From the results of laboratory tests, it has also been proven that these aquatic plants can absorb certain amounts of metal in the following table from the results of tests carried out

**Table 2. Accumulation of absorption of Fe and Mn elements by plants**

| Plant type            | heavy metal | Accumulation (pp/gram dry weight) | Stem |
|-----------------------|-------------|-----------------------------------|------|
| Kiambang (Salvania natans) | Mn          | 7682                              | 516  |
|                       | Fe          | 13231                             | 2842 |
| Vetiver               | Mn          | 486                               | 119  |
|                       | Fe          | 3964                              | 448  |
| Enceng Gondok         | Mn          | 1120                              | 1366 |
|                       | Fe          | 5350                              | 394  |
| Tipha                 | Mn          | 936                               | 1484 |
|                       | Fe          | 15116                             | 1432 |
| Pakis                 | Mn          | 1700                              | 1432 |
|                       | Fe          | 13923                             | 1432 |
| Mandoan               | Mn          | 526                               | 260  |
|                       | Fe          | 62686                             | 7642 |
From the table it can be seen that the absorption of Fe and Mn content is mostly absorbed in the roots of the aquatic plants. According to Marda\[1\] the spread and composition of Fe metal accumulates a lot at the bottom of the pond or in other words Fe besides absorbed by plants is also deposited by plants, then for Mn metal the spread and composition in the pond shows the same condition so that Mn metal is not easily deposited.

3.7. Effect of water plants on levels of Total Suspended Solid (TSS)

According to Risnawati \[5\] TSS is suspended materials that are not soluble in water. Suspended solids consist of particles whose size and weight are smaller than sediments. According to Hadiwidodo \[6\] the decrease in TSS levels in ponds because there is a connection with plant roots, the longer the plant roots, the TSS levels will decrease, the length of plant roots is directly proportional to the duration of the experiment and decreases in TSS levels in the pond. According to Arroyo \[3\], the decline in TSS is because plants have positively charged root hair that attracts opposite-charged colloidal particles such as suspended solids, so that the particles attach to the roots and are slowly absorbed and assimilated by plants and microorganisms.

3.8. Effect of water discharge on decreasing TSS levels

Water flow can affect the contact process between waste and decomposing microorganisms, in the constructed wetland method used here surface flow with the incoming water discharge is not too large, because the water discharge can affect the process of absorption of plants in absorbing metals, From the results of the author's observation, the relationship between water discharge and decreasing TSS levels can be seen in the following table:

| Comparison          | Week 1 | Week 2 | Week 3 |
|---------------------|--------|--------|--------|
| TSS Inlet (mg/l)    | 405    | 443    | 621    |
| TSS Outlet (mg/l)   | 6      | 3      | 2      |
| Debit (m^3/s)       | 0.21   | 0.14   | 0.08   |

Based on table 3 it can be concluded that the slower the water discharge in constructed wetland ponds, the higher the decrease in TSS levels that occur. Conversely, the faster the water discharge in constructed wetland ponds, the smaller the decrease in TSS levels.

4. Conclusion

From research conducted at PT. Bukit Asam, Tbk, the authors draw conclusions:
1. Acid mine water treatment applied by PT. Bukit Asam, Tbk with passive treatment technology, namely constructed wetland method.
2. Plants used with the constructed wetland method are using kiambang, vetiver, water hyacinth and kiapu.
3. Passive treatment of acid mine drainage applied by PT. Bukit Asam, Tbk, using constructed wetland methods is effective in decreasing levels of Fe and Mn.
4. The saturation time of plants in the constructed wetland method is 6 months, so that plants need to be renewed once every 6 months, so that the treatment of acid water with the constructed wetland method is maximal.
5. From the results of testing the pH value, the level of Fe metal, the metal content of Mn and the total residual thesis, it meets the applicable liquid waste quality standards in Minister of Environment Decree Number 113 of 2003, and the Governor of South Sumatra Number 8 of 2012.
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