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Research paper

The utilization of moringa (moringa oleifera) seed powder as a biocoagulant and flocculant in waste water treatment coal mining industry

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Abstract

Mineralogically, acid mine drainage consists of minerals such as silica, iron silicate, magnesium, sodium, potassium and sulfide. These minerals can undergo oxidation (especially pyrite oxidation) to form acidic salts with a pH of 2.8-3.4. Moringa seed powder activity test were performed by adding 30% H2O2 to coal waste water treatment; Moringa seed powder was added to 2 L of coal waste water and stirred for 50, 100, 150, 200, and 250 minutes. Observations were analyzed using the AAS (Atomic Absorption Spectofotometry) to measure the quality of degraded waste water and X-Ray Diffraction (XRD). The results showed that the pH value reached 7.6 in the addition of H2O2 at the mixing time of 250 minutes, the TSS level reached 0 at the stirring period of 250 minutes without the addition of Moringa oleifera powder, while the addition of H2O2 and Moringa oleifera seed powder decreased heavy metals with an average of 69.06%at the stirring period of 100 minutes.

Keywords:*Acid Mine Drainage; Moringa Seeds; Wastewater Treatment.*

1. Introduction

Coal mining activity is an activity that includes exploration, exploitation, refining processing, and minerals/mining materials transport. In addition to generating foreign exchange and absorbing jobs, the coal mining industry is also prone to environmental destruction. The impact of coal mining activities not only causes environmental damage, but it possessed other dangers that are suspected to be hidden by coal mining companies in Indonesia. Permanent damage due to land clearing, loss of various types of plants, soil geology, chemical weathering and a number of other environmental damage are only some of the negative impacts that can be seen in plain sight. [24] [10] Acid mine drainage (AMD) is a residue originated from the residue of ore processing after separating the main mineral target. Mineralogically, acid mine drainage consists of minerals such as silica, iron silicate, magnesium, sodium, potassium, and sulfide. Furthermore, these minerals can be oxidized (especially pyrite oxidation) to form acidic salts with a pH of 2.8-3.4. [13] [8] [22] Pollutants from coal mining waste water formed by acid mine drainage consist of heavy metals, namely, Iron (Fe), Manganese (Mn), Nickel (Ni), Copper (Cu), Zinc (Zn), Aluminum (Al), Chromium (Cr), Cobalt (Co), and Mercury (Hg), that have the potential to cause environmental pollution with negative effects in aquatic biota and human health, when they exceed the quality standard thresholds.

Various kinds of physical and chemical treatments or both treatment combination have long been used to remove heavy metals from the coal mining industry waste. For example, by separating heavy metal ions or with ion exchange resins, absorption uses activated carbon, electrodialysis, reversed osmosis, addition of coagulants and lime. However, these methods are very difficult, expensive, inefficient, and require a lot of energy and produces toxic deposits. [13] [22] [23] [18] [6] [4] Therefore, a study on the use of natural materials used to treat coal waste water is urgently needed.

Moringa oleifera known locally as moringa can be used as biocoagulant. Moringa seeds contain the bioactive compound rhmanosyloxy-benzyl-isothiocyanate, which can absorb, neutralize, and reduce the heavy metal particles contained in wastewater, thus potential to be used as a natural coagulant to purify the water, hence suitable for reuse and ensure the waste water is free of pollutants. [5] [2] [20] [21] The advantage of Moringa oleifera seeds as a biocoagulant compared to chemical coagulants is easy to cultivate in the surrounding environment, because the moringa seed plant can live in vast altitude areas from the coast to the highlands.

2. Method

Moringa seeds were dried at 105ºC for 24 hours, then weighed 1 kg. Dried moringa seeds were crushed with mortar and sieved using a 300 nm sieve. The moringa seed powder obtained was characterized to determine the structure and compounds in the moringa seed powder. Moringa seed powder activity test were performed by adding 30% H_2O_2 to coal waste water; Moringa seed powder was added to 2 L

of coal waste water and stirred for 50, 100, 150, 200, and 250 minutes. The observations were analyzed using the AAS (Atomic Absorption Spectofotometry) to measure the quality of degraded waste water and X-Ray Diffraction (XRD).

3. Results and discussion

3.1. XRD and SEM analysis results of moringa (moringa oleifera) seed powder

Moringa seed powder sized 300 nm can be said to be nanoparticles, according to the definition of Buzea et al, 2007 that the size of nanoparticles is 1 to 1000 nanometers. The particle size and profile of moringa seed powder were tested by Scanning Electron Micrograph (SEM). SEM data was enlarged 1000 times (1) showing a hollow powder profile and the results of PSA analysis of moringa seed powder with an average particle size of 336.50 nm with a poly dispersity index (PI) of 0,96 [7]. XRD results (Figure 2) showed Moringa seed powder is amorphous, not crystalline, whereas SEM results showed that the morphological type of moringa seed powder tends to form agglomerates [11].

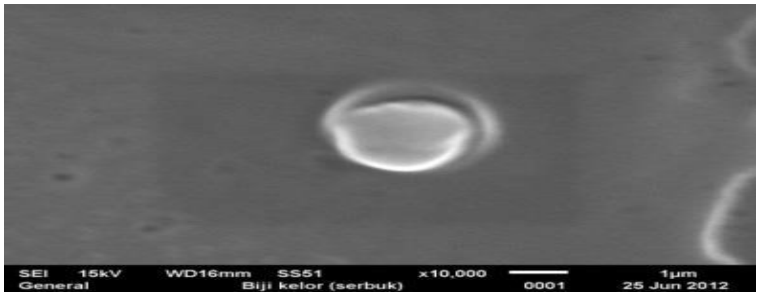

Fig. 1: Picture of Scanning Electron Micrograph (SEM) Moringga Seed Powder 1000x.

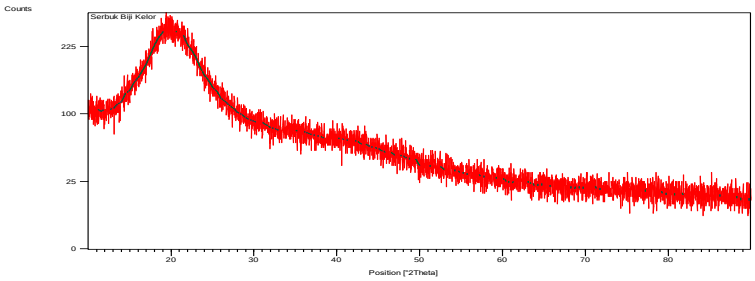

Fig. 2: Analysis Result of X-Ray Diffraction (XRD) Moringga Seed Powder.

3.2. Effect of H2O2 in coal wastewater quality

The management pattern for applying the most cost-effective method for the treatment of coal wastewater is flocculants or coagulants. Flocculants combined with chemicals such as H_2O_2 will create larger particles. [19] The most effective and inexpensive coagulant and flocculant in treating wastewater is H_2O_2 as hypochlorite and exhibiting very effective oxidation and has been shown to oxidize acid mine drainage and neutralize acidity. [12] This can be seen from the results of study in Table 1. There was an increase in the pH value from 2.68 to 7.5, a decrease in TSS levels of 200 minutes stirring period to 0 (zero) and the occurrence of metal deposition, [9] decreasing the heavy metal content, which forms a precipitation.

Table 1: Effect of Addition of $H_2O_2$to Coal Wastewater

Parameter	Wastewater Quality	Maximum Level*	Unit	Stirring period (Minute)				
				50	100	150	200	250
TSS	70	200	mg/L	55	30	19	0	0
pH	2.68	6 - 9	mg/L	6	6	6	6.3	7,5
Fe	15	7	mg/L	11.79	7.75	5.27	4.21	2.37
Mn	10	4	mg/L	9.99	8.45	7.78	7.45	6.78
Zn	5	5	mg/L	4.78	4.14	4.04	3.39	3.18
Hg	0.0045	0.002	mg/L	0.0031	0.001	0.001	<0.001	<0.0001
Cu	2.5	2	mg/L	2.41	2.01	1.98	1.56	1.19
Co	0.5	0.4	mg/L	0.03	0.01	0.009	0.003	0.001
Cr	0.7	0.5	mg/L	0.06	0.05	0.001	0.001	<0.001
Al	2.4	0.5	mg/L	2.21	2.10	1.73	1.11	0.01
Ni	0.25	0.2	mg/L	0.25	0.21	0.18	0.13	0.01

3.3. Effect of moringa (moringa oleifera) seed powder in coal wastewater quality

Moringa seeds act as an effective coagulant due to its active substance 4-alfa-4-rhamnosyloxy-benzyl-isothiocyanate play as antimicrobial with an efficiency of 85-93% and 93-100% coliform bacteria. [15] [5]Protein in moringa seeds plays a role in causing turbidity and as a cationic polyelectrolyte coagulant which can be used as a material for water purification processing by adsorption and charge neutralization. Moringa oleifera protein is cationic which binds to negative charges and compounds that bind metal ions, thus metal ions are deposited. [14]The amino acid of Moringa oleifera biocoagulant is ionized to produce carboxylic ions and protons, proton charges attract electrons (colloids) to form neutral groups and produce floc, resulting in water soluble cationic protein components, thus the solution becomes alkaline. [1]The results are shown in Table 2. The effect of Moringa powder on coal wastewater treatment, the TSS value

has not reached zero compared to using H_2O_2, the change in pH and heavy metal reduction is still significant. According to Sajidu et al, 2005, Moringa oleifera can be used to treat liquid waste contaminated with heavy metals by 86% with 60 minutes stirring period.

Table 2: Effect of Moringa Seed Powder on Coal Wastewater

Parameter	Wastewater Quality	Maximum Level*	Unit	Stirring period (Minute)				
				50	100	150	200	250
TSS	70	200	mg/L	67	54	40	22	11
pH	2.68	6 - 9	mg/L	5.3	5.3	5.9	6.2	6.4
Fe	15	7	mg/L	12.94	10.34	9.25	7.47	5.23
Mn	10	4	mg/L	9.79	6.75	5.27	5.13	3.21
Zn	5	5	mg/L	3.02	2.83	2.53	1.89	0.75
Hg	0.0045	0.002	mg/L	0.004	0.0035	0.0018	0.0003	<0.0003
Cu	25	2	mg/L	0.95	0.75	0.35	0.10	0.09
Co	0.5	0.4	mg/L	0.05	0.01	0.001	<0.001	<0.001
Cr	0.7	0.5	mg/L	0.5	0.01	<0.001	<0.001	<0.001
Al	2.4	0.5	mg/L	2.22	0.18	0.08	0.02	<0.001
Ni	0.25	0.2	mg/L	0.21	0.13	0.09	0.001	<0.001

3.4. Effect of using moringa seed powder H2O2 on coal wastewater quality

Factors affecting the effectiveness of Moringa oleifera powder as a biocoagulant are its active compounds namely 4-alfa-4-rhamnosyloxy-benzil-isothacynote [5]. This active substance is able to absorb waste particles. Palupi, 2006 found that the addition of H_2O_2 can increase the concentration of hydroxyl radicals, thus electrons separation may occur. Results of study in Table 3 shows the pH value reached 7,6 after H_2O_2additionat the stirring period of 250 minutes, the TSS level reached 0 at 250 minutes without the addition of Moringa oleifera powder, while the addition of H_2O_2 and Moringa oleifera seed powder decreased the heavy metals by averagely 69.06% with 100 minutes stirring period.

Table 3: Effect of Moringa Seed Powder + H_2O_2 in Coal Wastewater

Parameter	Wastewater Quality	Maximum Level*	Unit	Stirring period (Minute)				
				50	100	150	200	250
TSS	70	200	mg/L	55	30	19	7	0
pH	2.68	6 – 9	mg/L	5.5	6	6.2	6.5	7.6
Fe	15	7	mg/L	7.06	6.94	4.64	2.39	0.29
Mn	10	4	mg/L	7.5	3.9	2.3	0.11	0.09
Zn	5	5	mg/L	0.68	0.56	0.35	0.13	0.078
Hg	0.0045	0.002	mg/L	0.003	0.001	<0.001	<0.001	<0.001
Cu	2.5	2	mg/L	0.03	0.01	0.009	<0.001	<0.001
Co	0.5	0.4	mg/L	0.03	0.011	0.001	<0.001	<0.001
Cr	0.7	0.5	mg/L	0.023	0.001	<0.001	<0.001	<0.001
Al	2.4	0.5	mg/L	2.0	0.15	0.09	0.04	<0.001
Ni	0.25	0.2	mg/L	0.13	0.18	0.09	0.06	<0.001

4. Conclusion

The utilization of moringa (Moringa oleifera) seed powder with the addition of H_2O_2 as a biocoagulant has been shown to improve the quality of coal mining wastewater by reducing TSS levels at 250 minutes stirring period could decrease the pH value by 7.6 and reduce the heavy metals by 69.06% at 100 minutes stirring period.

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