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Bioremediation of Chrome Heavy Metals On Metal Coating Waste With *Bacillus subtilis* Bacteria

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Abstract. The chrome metal coating industry can produce toxic waste, and if it is disposed of freely, it will cause severe contamination of soil and water. Chrome metal pollution needs to be minimized, considering the impact caused besides polluting the environment also disrupts human health and other living things. Measures to reduce or even eliminate these hazards by treating waste before being discharged into free water. Wastewater technology that contains heavy metals can be reduced using bioremediation. Research has been carried out on samples of metal coating industry wastewater containing heavy metal chromium with 2.5161 ppm on initial levels. *Bacillus subtilis* bacteria with various concentrations with unit cells/ml ($10^{2.5}$ and 10^5) were added to the samples and stored for two days. Chromatic metal levels after bioremediation were measured by spectrophotometry. Bioremediation with *Bacillus subtilis* can reduce chromium metal content by 91.33% and 80.24% at concentrations of $10^{2.5}$ and 10^5. Bacillus subtilis were $10^{2.5}$ cells/ml lower chromium metal levels higher than that of *Bacillus subtilis* 10^5 cells/ml.

INTRODUCTION

Electroplating is to coat one metal with another such as coating iron metal with chrome metal. Metal coating processes that produce waste can cause contamination of soil and water (1). Disposal of metal coating industry wastewater produces a small volume of waste but has high toxicity when seen from the parameters of chrome metal (2), (3). Chrome metal toxicity in the form of hexavalent chrome ions can cause gene mutations, carcinogenic (3)(4), and teratogenic (5), to humans. In the food chain, chrome metal accumulation can be very toxic and causes health problems in the human body (6).

The level of chrome heavy metal pollution from the metal coating industry is regulated in the Regional Regulation of Central Java Province Number 5 of 2012 about the Standard Quality of Wastewater of the Metal Coating Industry, which is a maximum of 0.5 ppm (7). Chrome metal is very dangerous, so it needs to be reduced or eliminated.

The reduction of heavy metals in the liquid waste can be made by chemical and physical methods such as electrocoagulation (8),(9),(10), electrodialysis (11), (12), precipitation (11), adsorption (13), (14), and biology (15) namely biosorption (16) and bioremediation are ways of treating waste using microorganisms, such as fungi and bacteria to reduce pollutants in the environment by involving passive uptake or biosorbtion processes and active uptake processes that occur in living cell types (1). Bioremediation is proven to be able to overcome pollution from toxic compounds in the soil (17). Some examples of microorganisms that can be used in the process of biosorption of heavy metals from bacterial groups include *Bacillus firmus, Streptomyces sp., Pseudomonas aeruginosa*, *Bacillus cereus* (18), *Bacillus sp*.(1).

Bacillus subtilis was used in bioremediation of metal coating heavy metal industry liquid waste treatment. The variation of concentration was 0 cells/ml; 10^5 cells/ml, and $10^{2.5}$ cells/ml, using 48 hours (2 days) incubation time. Chromium heavy metal content before bioremediation and changes in chromium metal content after bioremediation were measured by the Spectrophotometry method.

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RESEARCH METHOD

Tools

The tools used in this study were: test tubes, sample bottles, volume pipettes, measuring cups, beaker glass, centrifuge, drop pipettes, vials, Whatman 42 filter paper, pH sticks, *Atomic Absorption Spectrophotometer* (AAS).

Materials

The materials in this study were samples of electroplating industrial wastewater, Bacillus subtilis, aqua dest, label paper, standard chrome solution, 0.2 N H_2SO_4 solution, concentrated HNO_3 solution, LB media (Luria Bertany).

Bioremediation of Chrome Metal Processing in Liquid Metal Coating Liquid

The stages of bioremediation of metal coating industry wastewater treatment with Bacillus subtilis with concentration (0; $10^{2.5}$; 10^5) cells/ml are carried out as follows.

1. Propagation of the *Bacillus subtilis* was grown on LB (*Luria Bertany*) medium, 2-3 ose was put into the 100 ml medium, then incubated at 37^0 C for two days.
2. *Bacillus subtilis* were added to the samples with concentration variation 0, $10^{2.5}$, and 10^5 cells/ml. Samples incubates for 48 hours (2 days) at 37^0C.
3. 100 ml of liquid waste is then acidified with 5 ml of concentrated HNO3, heated until the temperature is dissolved with 50 ml of distilled water. This solution was flung into a 100 ml measuring flask and filled with H2SO4 2 N, then read the absorbance with a Spectrophotometer.

RESULT AND DISCUSSION

Results

Chromium content in metal coating industry wastewater study was carried out through the stages of determining initial levels before bioremediation (concentration 0 cells/ml). The determination of chrome metal levels after bioremediation with variations in the concentration of Bacillus subtilis (10^5 cells/ml and $10^{2.5}$ cells/ml) incubation two days. The reduction in the level of chrome metal is presented in figure 1, as follows.

Chromium metal content before and after bioremediation with variations in the concentration of *Bacillus subtilis* bacteria are presented in the graph in Figure 1.

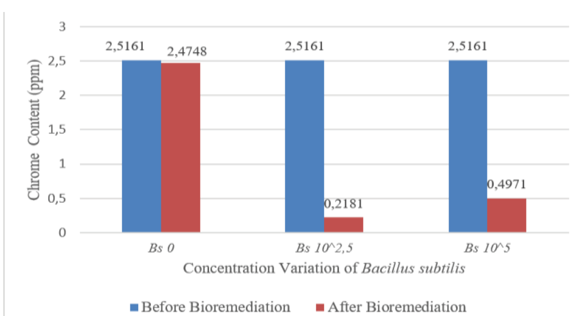

FIGURE 1. Reduction of Chrome Metal Content by Bioremediation

The percentage reduction in chrome metal content is presented in figure 2, as follows.

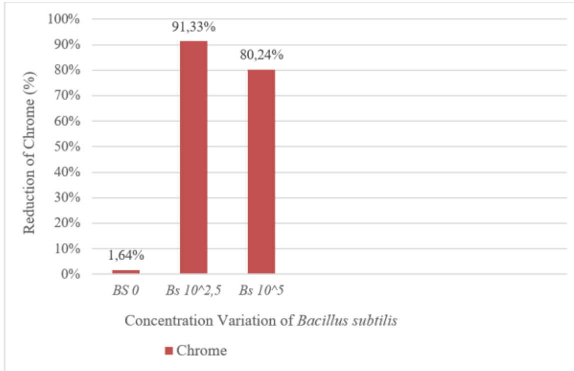

FIGURE 2. Percentage Reduction In Chrome Metal Content

Discussion

Bioremediation with *Bacillus subtilis* was carried out to overcome environmental pollution (16). The mechanism of *Bacillus subtilis* in reducing chromium heavy metal pollutants in industrial liquid waste is done by absorbing the heavy metal from the waters into cells actively uptake and passive uptake (1).

Figure 1. shows the change in chromium metal content with *Bacillus subtilis* with concentration (0, $10^{2.5}$ and 10^{5}) cells/ml, incubation time two days, 0 cell/ml concentration has decreased chromium content of 0.0413 ppm. *Bacillus subtilis* $10^{2.5}$ cells/ml showed a decrease in higher levels of chromium metal than a concentration of 10^{5} cells/ml decreased. In liquid waste naturally contained by microbes, the presence of microbial activity naturally can absorb chrome in the waste.

Figure 2 shows the percentage reduction in chromium metal content by *Bacillus subtilis* concentration of $10^{2.5}$ cells/ml by 91.33%, concentration of 10^{5} cells/ml by 80.24%. Air humidity and osmosis pressure factors affect bacterial growth (19), humidity is related to the amount of water, the amount of water influences bacterial growth becomes more and more, causing the ability to absorb heavy metal chromium in the waste is greater(20), as shown in the use *of Bacillus subtilis* $10^{2.5}$ cells/ml. The end result of chrome metal content after bioremediation processing has met the applicable quality standards (7).

CONCLUSION

The reduction of chromium metal content with $10^{2.5}$ cells/ml and 10^{5} cells/ml of *Bacillus subtilis* was 91.33% and 80.24% respectively. The concentration of $10^{2.5}$ cells/ml was proven to reduce levels higher than 10^{5} cells/ml of *Bacillus subtilis*.

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