BIOREMEDIASI LUMPUR MINYAK BUMI DENGAN ZEOLIT DAN MIKROORGANISME SERTA PENGUJIANNYA TERHADAP TANAMAN SENGON (*Paraserianthes falcataria* L. Nielsen)

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ABSTRAK

Telah dilakukan penelitian bioremediasi lumpur minyak bumi dengan zeolit dan mikroorganisme yaitu dengan bakteri *Pseudomonas mallei, Bacillus alvei* dan *Bacillus nigricans* dengan sengon (*Pasaserianthes falcataria* L. Nielsen) sebagai tanaman uji. Penelitian terdiri dari tiga tahap (1) penggunaan zeolit sebagai penyerap logam berat (2) penggunaan konsorsium bakteri, jamur dan mikroorganisme *indigenous* pada setiap taraf lumpur minyak dengan zeolit optimum hasil percobaan pertama (3) pengujian medium hasil bioremediasi dengan sengon sebagai tanaman uji.

Hasil uji TCLP menunjukan bahwa zeolit dapat menurunkan kandungan logam berat Pb, Cd, Cr, Cu, Ni dan Zn. Konsentrasi lumpur minyak 20% dan zeolit 10% dapat menurunkan kadar logam berat seng (Zn) 40%, kandungan minyak dan poliaromatik hidrokarbon (PAH) masing-masing sebesar 23,18% dan 14,16% serta berpengaruh terhadap jumlah jamur dan bakteri.

Penggunaan bakteri *Pseudomonas mallei, Bacillus alvei* dan *Bascillus sphaericus* pada lumpur minyak 20% dan zeolit 10% dapat menurunkan kandungan Zn sebesar 16,17%, kandungan minyak dan poliaromatik hidrokarbon masing-masing sebesar 18,76% dan 10,34%. Sedangkan penggunaan jamur *Aspergillus oryzae, Glicladium roseum* dan *Penicillium nigricans* menurunkan kandungan Zn 10,8%, kandungan minyak dan poliaromatik hidrokarbon masing-masing sebesar 12,99% dan 10, 47%. Berpengaruh terhadap jumlah mikroorganisme yang ditandai dengan adanya aktifitas enzim protease masing-masing sebesar 2760 unit dan 2700 unit.

Biomasa tanaman sengon (*Paraserianthes falcataria* L. Nielsen) sebagai tanaman uji mengalami pertumbuhan 6,83 g, sedangkan dengan penambahan inokulan jamur biomasa tanaman sengon sebesar 3,87 g, kandungan logam berat Zn dan PAH sebelum dan setelah penanaman sengon menurun masing-masing sebesar 15,6% dan 23,6%

Kata Kunci : bioremediasi, zeolit, sengon

Oily sludge bioremediation with zeolite and microorganism and it's Test with Albizia Plant (*Paraserianthes falcataria* L. Nielsen)

ABSTRACT

A research of oily sludge bioremediation with zeolite and microorganisms adding Pseudomonas mallei, Bacillus alvei, Bacillus sphaericus bacteria *and* Aspergillus oryzae, Gliocladium roseum *and* Penicillium nigricans *fungi with albizia* (Paraserianthes falcataria *L. Nielsen*) as test plant has been conducted. *The research consist of three steps (1) using zeolite as heavy metal adsorbent (2) adding and using bacteria, fungi and indigenous microorganism (natural) consortium on every level of oily sludge with optimum zeolite as a result of the first research (3) medium testing as a result of oily sludge bioremediation with albizia as a test plant.*

The result showed that generally zeolite 10% in oily sludge 20% with the use of bacteria was able to decrease heavy metal zinc (Zn) 40%, oil content also polyaromatic hydrocarbon (PAH) 23.18% and 14.16% respectively and influence to number of fungi but not associated with bacteria community.

Oily sludge 20% and zeolite10% decrease content of heavy metals Pb, Cd, Cr, Cu, Ni and Zn using TCLP. Bioremediation using bacteria decrease content of Zn 16.17%, oil content also reduce content of Polyaromatic hydrocarbon (PAH) 18.76% and 10.34% respectively. On site treatment using fungi achieving removal rates of Zn 10.8%, oil content also PAH were 12.99% and 10.47%.

The utilizing bacteria and fungi to degrade oil sludge mixed in the soil as land treatment associated with microbial density and activity protease enzyme 2760 and 2700 units, the processes employed were shown to number of bacteria and fungi.

The growth and biomass of albizia as test plant in bacteria medium was 6.83 g, and the positive impact in fungi in fungi medium growth 3.87 g, compared with control. Before and the end of plant test content of metal Zn and PAH decreases at 15.6% and 23.6 respectively.

Keywords : bioremediation, zeolite, sengon

Introduction

Oily sludge are final waste of a connected process in oil industry that consists of polyalifatic and polyaromatic hydrocarbon compound such as, water, metal element (Cd, Cr, Pb, Zn, Ni, Cu) and non hydrocarbon, with compounds such as nitrogen, sulphur, oxygen, and asphalt (Scora *et al.,* 1997).

Based on the current regulation used, which is Government regulation number 85 in 1999 about waste processing, the oily sludge waste is listed in The Hazardous and Toxically Waste, excellent waste processing are required to avoid polluted natural surroundings (Bappedal, 2001). Connected to that is a conclusion of The Environment Minister number 128 in 2003, oily sludge processing is extremely needed in order to achieve environment restoration, with biological restoration (The Ministry of Environment, 2003) or is well known as bioremediation.

The obstacle factor of bioremediation is the remediate material is consisted with chlorine or heavy metal that can effect the organic disentangling. Early handling processing is needed before bioremediation using natural adsorbent like zeolite.

Bioremediation using only indigenous microorganisms has not yet shown a maximum result, these consequences needed an inoculated ecsogenous microorganism. The microorganism is mixed culture (consortium) of many bacteria or fungi that are potentials in degrading the waste. Mishra *et al.,* 2001). Furthermore, compos medium from bioremediation is used as a growing test medium of sengon *Paraserianhes falcataria* L. Nielsen in green house scale.

1.1. Research Methods

1.2.1 Introduction Research

Before the main research is done, introduction must be conducted first with conducting a TCLP test (Toxicity Characteristic Leaching Procedure) based on US EPA-SW-846 method 1311.

1.2.2 First Experiment

Zeolite has the ability to absorb heavy metal and reducing the total of hydrocarbon in oily sludge.

This experiment is conducted with 3x4x3 design of random factorial pattern that are factor I: oily sludge (L) consists of three standards which are 10% (1_1) oily sludge,

20% (1_2), 30% oily sludge (1_3). Factor II: Zeolite (Z) consists of four standards which are: Control (z0), zeolite 10% (z1), zeolit 20% (z2), zeolit 30% (z3) with three repeats. Medium are incubated for 6 weeks. The measured parameters are: contents of zinc heavy metal (Zn), contents of fat and oil, polyaromatic hydrocarbon, total of fungi and bacteria.

1.2.3 Second Experiment

The ability of microorganism inoculant in reduces the amount of heavy metal and hydrocarbon.

This experiment is conducted with 3x3x3 design of random factorial pattern. Factor I: First result of concentrated oily sludge (L) three standards, which are, 20% (optimum) (1_1), 25% (1_2) and 15% (below optimum) (1_3). Factor II: Microorganism inoculant (B), bacteria (b_1), fungi (b_2) and without microorganism addition (b_3). The measured parameters are: contents of zinc heavy metal (Zn), contents of fat and oil, polyaromatic hydrocarbon, total of fungi and bacteria, and also active protease enzyme.

1.2.4 Third Experiment

The test that conducts composed oily sludge and sengon for purposes of seeing sengon's heavy metal and hydrocarbon degrading absorbing ability. The first experiment design is similar to the second experiment design.

1.2. Results

1.2.1. TCLP Test

In TCLP test, the content of heavy metal in oily sludge medium are given zeolite processed, analyzed with AAS and the data are shown in Table.1. The heavy metal consisted in Ni and Pb has more value than the standard quality which is 58.21 ppm and 7.9 ppm. However, after the TCLP test, this metal has a very small value between <0.01 - <0.1 ppm.

The research result showed that there is metal adsorption Cu, Zn, Pb, and Cr by zeolite at concentrated of 10%, 20% and 30%. However, there is a different case with Zn, alkali detected at around 0.196 – 1.065 ppm, whereas Ni alkali is not detected for the entire medium at 1_3z_1 and 1_3z_3 with the value of 0.121 – 0.394 ppm. The second metal content is alkalized at many medium composition fulfilled the quality standards and appropriate with the oily sludge final processing criteria which are 50 ppm, according to

conclusion of The Minister of Environment number 128 in 2003 and Government Regulation number 85/1995.

1.2.2. First Experiment

After two weeks of compositing, medium of LMB 20% and zeolite 10% (1_2z_1) decreasing 40% Zn, whereas the usage of zeolite 20% (z_2) at the same sludge concentration decreasing Zn 22% and 13%.

At the same medium (1_2z_1) decreased percentage of PAH at 14.16%, are higher than any other processing that followed by $1_3z_1$and 1_2z_3 each at 12.83% and 12.07%. These decreasing are caused by interacted materials in the medium, without zeolite usage or mixture with decreasing PAH sand only 5.21%. At first concentration of LMB which are 10%, 20% and 30%, gradually showed a decreasing of fat and oil content in the third week, each at 13.67% and 18.21%.

1.2.3. Second Experiment

The result showed the usage of bacteria inoculants *Pseudomonas mallei, Basillus alvei* and *Bacillus sphaericus* can decrease Zn at 16.7%, the fat and oil content also PAH each at 18.76% and 12.99%. While the usage fungi inoculants contents of *Aspergillus oryzae, Gliocladium roseum* and *Penicillium nigricans* decrease the Zn 10.8% content, the fat and oil content also polyaromatic hydrocarbon content each at 12.99% and 10.4%. The usage of fungi and bacteria affected the total of indigenous microorganism and enzyme protease activity, each at 2760 units and 2700 units.

1.2.4. Third Experiment

As a test plant, sengon (*Paraserianthes falcataria* L. Nielsen), growing in bioremediation medium, the plant biomass increased 6.83 g, it was planted in the composed and addition of bacteria inoculants medium. Whereas the addition of fungi inoculants biomasses sengon at 3.87 g, the content of Zn heavy metal and PAH, before and after the sengon planting decreased at each 15.6% and 23.6%.

1.3. Result

1. The TCLP test showed that zeolite has the ability of absorbing heavy metal Pb, Cd, Cu, Cr, and Ni, whereas Zn still can be detected. The concentration of oily sludge waste 20% and zeolite 10% (1_2z_1) are optimum medium in decreasing metal, fat and oil also polyaromatic hydrocarbon (PAH).

2. Medium of oily sludge 20% and zeolite 19%, inoculated by *Pseudomonas mallei, Bacillus alvei, Bacillus sphaericus* and *Aspergillus oryzae, Glicladium roseum and Penicillium nigricans* after three weeks of compositing can decreas Zn content, fat and oil and also polyaromatic hydrocarbon. Besides that, the fungi and bacteria inoculants usage affect the total of microorganism which was signaled by the appearance of protease enzyme activity.
3. The results showed that sengon has the ability of growing in bioremediation medium with biomasses addition and also the sengon height. From the entire bioremediation research process and after sengon planting, the medium composition of oily sludge 20% and zeolite 10% can decrease the percentage of Zn content valued 65%, fat and oil each at the value of 41.48% and PAH 30.10%.

1.5. Advisory

1. The optimalzed biomediation oil and sludge 25% and zeolite 10%, are advised to applicant with a longer composting of three months time.
2. A field test experiment requires specific design to avoid leaching.
3. The usage of sengon is advised to use in oily sludge fitoremediations As a fast growing trees as well as Leguminosaes, sengon has the potential to synergize with rhizosfir microorganism that helped in the xenobiotic oily sludge minimal zed.

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