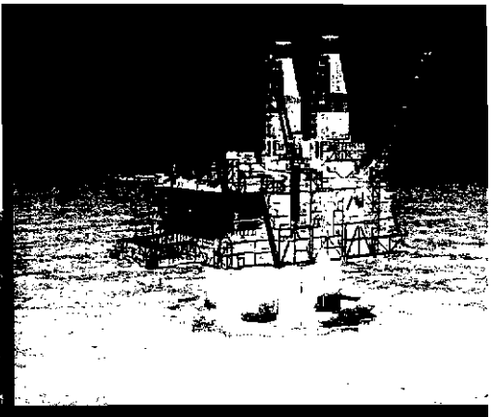

Environmental Protection and Management

Proceeding

SIBE-2009

The 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries

SABUGA ITB, Bandung - Indonesia
2nd - 3rd November 2009

Published by
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SIBE 2009 published eight (8) volumes of proceeding as following :

Volume A : Structure and Material
Volume B : Transportation System and Engineering
Volume C : Water Engineering and Management
Volume D : Waste Engineering and Management
Volume E : Ocean Engineering
Volume F : Construction Management
Volume G : Geotechnical Engineering
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PREFACE

The 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries (SIBE) 2009 is aimed to provide a forum to discuss and disseminate recent advance in scientific research, technology, and management approach to obtain better environment quality.

Infrastructure that provides the basic need of a society and sustainable infrastructure system are essential for the survival, health and well-being of a society. In developing countries, civil and environmental engineers are at the epicenter in seeking means to enhance the quality of human life through modernization of infrastructure as evidenced by provision of shelters, water, and transport, amongst others. The current rate of urbanization and industrialization raises a number of environmental issues, often resulting in environmental mismanagement, especially in developing countries. The problems are further aggravated by environmental degradation such as soil erosion, depletion of water resources, etc. In order to meet these multifaceted challenges, proper planning followed by implementation and verification must be exercised, via an integrated, multi disciplinary and holistic approach.

The conference will provide an opportunity for professionals and researchers to learn, share and exchange about the latest development and research in civil and environmental engineering. The scope of the conference covers all aspect of civil and environmental engineering practices.

Participants of the conference include researchers, academic staffs, students, industries, public and local governments. The keynote presentations during the conference are as follows:

Keynote speakers:

- **Indonesian Government Representative**
  Minister of Public Works, Indonesia
- **Dr. Puti Farida Marzuki**
  Dean of the Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Dr. Tony Liu**
  National Taiwan University, Taiwan
- **Prof. Shunji Kanie**
  Hokkaido University, Japan
- **Prof. Syunsuke Ikeda**
  Tokyo Institute of Technology (AUN/SEED-Net), Japan.

Invited speakers:

- **Dr. Setiawan Wangsaatmaja**
  Environmental Protection Agency of West Java Province, Indonesia
- **Dr. Edwan Kardena**
  Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Prof. Harianto Rahardjo, Ph.D.**
  School of Civil and Environmental Engineering, Nanyang Technological University, Singapore
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- **Prof. Nakasaki Kiyohiko**
  Tokyo Institute of Technology, Japan.

The objectives of this conference are:

1. To provide a platform for exchange of ideas, information and experiences among academics, researchers, consultants, engineers, manufacturers and post graduate scholars in civil and environmental engineering.
2. To discuss and evaluate the latest approaches, innovative technologies, policies and new directions in infrastructure development, pollution prevention and eco-friendly technologies adapted to developing countries.
3. To promote cooperation and networking amongst practitioners and researchers involved in addressing infrastructure and built environment issues.

The oral and poster presentations are subdivided into 8 major sections, as following:

A. Structure and material
B. Transportation system and engineering
C. Water engineering and management
D. Waste engineering and management
E. Ocean engineering
F. Construction management
G. Geotechnical engineering
H. Environmental protection and management.

There are 176 contributors in oral presentation and 36 contributors for poster presentation.

Finaly, the Organizing Committee wishes that this conference is able to provide beneficial scientific information to the participants and other concerned readers.

Bandung, November 2009
Organizing Committee

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CONTENT

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Preliminary Experimentation of CO_2 Adsorption on Activated Carbon

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Abstract
The role of CO_2 in Global Warming is well known, while it is now not included within the existing emission standard in Indonesia. CO on the other hand is being limited, and the existing technology is encouraging emitters to convert CO into CO_2, e.g., using catalytic converters for motor vehicles. This experiment is meant to find the feasibility of CO_2 adsorption on Activated carbon, for any burning facilities to reduce CO_2 emissions. Activated carbon is used because of its abundance in Indonesia, hence its low cost. Due to limited existing resources, emissions in this experiment were taken from two types of motorbikes (two and four stroke type). Activated carbon (AC) are of granule type, taking into account that the expected vapor pressure will be low. Length of activated carbon were determined by preparing a tube having the same diameter as a motorbike exhaust pipe, to serve as activated carbon column. The 50 cm pipe was filled completely with AC, than, exhaust gas was run through this column, and velocity pressure (VP) was measured at the end of the tube. Whenever, no VP could be measured, the length of the AC column was decreased, until VP could be measured. The determined maximum length turned out to be 30 cm. Since adsorption curve was non linear, the length of AC column was varied as 30, 25, and 20 cm. CO_2 concentration was measured using Orsat method which produced % of CO_2 measured. The CO_2 concentration, ambient temperature (T) and Pressure (P) were measured before and after the exhaust gas passed through the AC column to convert its volume into the STP conditions. The CO_2 concentrations before and after diffusion through the AC column were then used to calculate the adsorption efficiency. The results showed that CO_2 concentrations before the adsorption for 2 stroke and 4 stroke type were 113.705 mg/l and 146.739 mg/l. CO_2 concentration with the length of AC column of 30, 25, and 20 cm, after the adsorption process, their efficiency for the 2 stroke type were 113.137 mg/l and 50.89%; 100.851 mg/l and 24.57%; 65.668 mg/l and 20.35%; for the 4 stroke type was 116.875 mg/l and 67.35%; 56.145 mg/l and 61.73%; 47.969 mg/l and 20.35%. Respectively, maximum adsorption efficiencies for the 2 stroke (50.87%) and the 4 stroke bikes (67.35%) occurred at 30 cm of AC column which was the maximum adsorbent length, where gas was still capable of passing through the adsorbent column. Based on adsorption theory, for a ventilation system on the other hand, the length required to reach 90 % efficiency was 120 cm. It is recommended that further research should be conducted for the feasibility of the application of adsorption systems for motorbikes and any other burning facilities.

Keywords : activated carbon, adsorption, carbon dioxide, efficiency.

1. Introduction

Background Problem

The role of CO_2 in Global Warming is well known, while it is now not included within the existing emission standard in Indonesia. CO on the other hand is being limited, and the existing technology is encouraging emitters to convert CO into CO_2, e.g., using catalytic

converters for motor vehicles. This experiment is meant to find the feasibility of CO_2 adsorption on Activated carbon, for any burning facilities to reduce CO_2 emissions. Activated carbon is used because of its abundance in Indonesia, hence its low cost.

2. Materials and Method

2.1. Materials

Due to limited existing resources, emissions in this experiment were taken from two type of motorbikes (two and four branch type). Activated carbon (AC) are of granule type, taking into account that the expected vapor pressure (VP) will be low.

2.2. Methods

2.2.1. Length of activated carbon Determination

Length of activated carbon was determined by preparing a tube having the same diameter as a motorbike exhaust pipe, to serve as activated carbon column. The 50 cm pipe length and 6 cm in diameter was filled completely with AC, than, exhaust gas was run through this column, and VP was measured at the end of the tube. Whenever, no VP could be measured, the length of the AC column was decreased, until VP could be measured. The determined maximum length turned out to be 30 cm. Since adsorption curve is non linear, the length of AC column was varied as 30, 25, and 20 cm.

2.2.2. CO_2 concentration measurement

CO_2 concentration was measured using Orsat method which produce % of CO_2 measured. This method is based on SNI 0029 : 2008. The concentration should therefore be calculated using the following formula :

$$\text{carbon dioxide concentration} = \frac{100 - \text{volume of gas remained in orsat (ml)}}{100} \times 100\% \qquad (1)$$

At the same time, ambient temperature (T) and Pressure (P) were measured before and after the exhaust gas passed through the AC column to convert its volume into the STP conditions.

2.2.3. Adsorption efficiency calculations

The concentration before and after diffusion through the AC column can then be used to calculate the efficiency in the following way:

$$\text{Adsorption Efficiency} = \frac{CO_{2_{before}} - CO_{2_{after}}}{CO_{2_{before}}} \times 100\% \qquad (2)$$

2.2.4. Effective Length Determination

The length required to reach maximum efficiency can be calculated with the following formula :

$$t_{10} = \frac{3.85 \times 10^7 \times W_c \left(a + b \cdot t_{pp}\right)}{Q \times M \times C^{2/3}} \qquad (3)$$

Where :

t_{10} = time to reach 90% reduction of contaminants
W_C = adsorbent weight, lb
a, b = experimental coefficients
t_{pp} = contaminant boiling point, ^0C
Q = sample flow-rate, ft^3/min
M = molecular weight of contaminants
C = concentration of contaminant entered the adsorbent column, ppm

3. Results and Discussion

The average concentration of CO_2 either from the 2 stroke or 4 stroke type were taken from 6 samples measurements. The CO_2 concentrations before and after adsorption process through the AC column were then used to calculate the adsorption efficiency.

CO_2 Concentration Before The Adsorption

Table 1 and Figure 1 show the average concentrations of CO_2 before the adsorption process of 2 stroke type and 4 stroke type, and the concentrations were used as initial concentrations for CO_2 adsorption efficiency calculation.

Table 1 Initial concentration of CO_2 (before the adsorption process)

No	CO_2 (2 stroke type)		CO_2 (4 stroke type)	
	Ppm	mg/l	ppm	mg/l
1	62812.031	112.805	83749.375	150.407
2	86643.359	155.604	97145.584	174.465
3	71415.132	128.256	91019.286	163.463
4	79350.146	142.506	73398.140	131.817
5	79476.904	142.734	672142.242	120.711
6	66999.500	120.236	77716.467	139.572
Average		133.705		146.739

From Table 1, the initial concentration for 2 stroke (133.705 mg/l) was higher than 4 stroke type was (146.739 mg/l). The difference was caused by the fuel combustion system. In a 4 stroke type engine, complete oxidation of hydrocarbon fuel was obtained, thus yielding more CO_2 than CO as combustion products, since the O_2 supply was totally used for fuel combustion, resulting in the very low concentration of unburned hydrocarbon, hence all hydrocarbon reacted with O_2 to formed CO_2. However, the CO_2 concentration of an exhaust from internal combustion engine of motorbikes are influenced by a number of factors, such as the following : air – fuel ratio, ignition timing, compression ratio, engine speed, combustion chamber geometry and type of fuel (Seinfield, 1986).

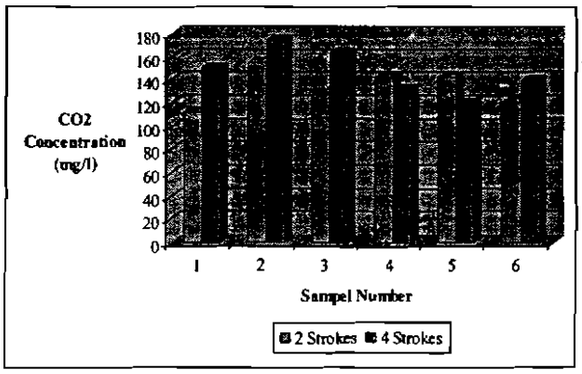

Figure 1 CO_2 concentrations before the adsorption process

CO_2 Concentrations After The Adsorption

Based on the preliminary experiments, the maximum length of AC was 30 cm. If the column were longer than 30 cm, vapor pressure of gas would be decreased significantly and cannot be measured by a manometer, which means the gas was unable to pass through the column, and the adsorption process would not occur.

The average of CO_2 concentrations after the adsorption process either for 2 stroke or 4 stroke type (Table 2 and 3) were lower than their initial concentrations; and the average of CO_2 concentrations for the 4 stroke type after the process were higher than 2 stroke type. The maximum reduction of CO_2 concentrations occurred when the gas stream passed through the

30 cm column. It means that the removal efficiency was correlated with the column length. The length of AC is equal to the surface area of its pores. The occupied surface area by granular AC range from 0.5 to 2 m^2/gram (Ruthven, 1984), therefore AC occupied in adsorption column with the length 20 cm, 25 cm and 30 cm were 0.54 kg, 0,675 kg and 0,81 kg respectively, and the total porous surface area at the AC length of 20 cm were 1080 m^2, at 25 cm were 1350 m^2 , and at the 30 cm were 1620 m^2. The adsorption process in this fixed bed occurred in a series of three steps. In the first step, the contaminants diffused from the bulk of gas stream to the external surface of AC. In the second step, the CO_2 molecule migrates from the relatively small area of external surface to the macro-pores, transitional pores, and micro-pores within each adsorbent. Most adsorption occurred in the micro-pores because the majority of available surface area were there. In the third step, the CO_2 molecule adheres to the surface in the pore. Therefore, the higher the surface area for adsorption, the higher AC capacity to adsorb CO_2 .

Table 2 CO_2 Concentration After The Adsorption for 2 Stroke Type (mg/l)

Samples	The length of AC column		
Number	20 cm	25 cm	30 cm
1	141.278	46.693	92.481
2	89.99	39.287	38.659
3	171.019	62.759	65.842
4	117.731	47.024	122.504
5	74.236	62.659	43.895
6	84.565	78.449	30.626
Average	**113.137**	**56.145**	**62.668**

Table 3 CO_2 Concentration After The Adsorption for 4 Stroke Type

Samples	The length of AC column		
Number	20 cm	25 cm	30 cm
1	133.855	123.324	62.057
2	75.110	61.863	61.856
3	124.313	92.794	58.272
4	147.145	102.101	62.257
5	115.602	122.923	30.978
6	105.496	100.851	12.391
Average	**116.875**	**100.851**	**47.969**

Efficiency of CO_2 Removal After The Adsorption

Based on the concentrations before and after the adsorption, the CO_2 removal efficiency of the 2 stroke type with the AC length 20 cm, 25 cm, and 30 cm were 15.68%, 61.73% and 50.87% respectively, as for the 4 stroke type, with the AC length 20cm, 25 cm, and 30 cm were 20.35%, 24.57% and 67.31% respectively. The efficiencies of CO_2 removal with the variation of AC length of these motorbikes are illustrated in the Figure 2, as follows :

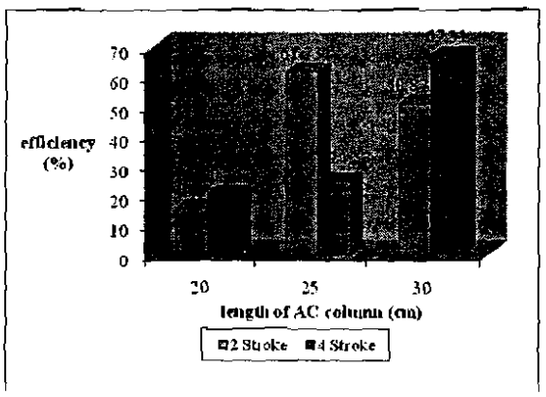

Figure 2 The CO2 removal efficiencies for 2 and 4 stroke type

The 2 stroke type produces not only CO_2 but also CO with a concentration higher than the 4 stroke type. CO could also be adsorbed by AC such as the case with CO_2; as a result most of the attachment areas for CO_2 were occupied by CO. Besides, incomplete combustion in a 2 stroke type, oil was found as fuel residue, exhausted within the gas stream that was adsorbed by AC. As is well- known, hydrophobicity is one of the AC properties, for that reason, AC tend to also bind oil. Meanwhile, the ideal of complete combustion of the 4 stroke type, yields more CO_2 than CO, and the unburned fuel in the exhaust gas stream are very low, hence the adsorbate adsorbed by the AC consist mostly of CO_2 than CO and oil.

Effective Length Determination

The length required to reach maximum efficiency was calculated with the equation that is usually used to design adsorption column in an air cleaner device (McDermot, Henry. 1979). See Table 5 for coefficient calculation. The values obtained for coefficient a was 3.4933, and for b 0.0365. Based on these coefficient values, theoretically, the column length required to reach 90 % efficiency was 120 cm.

Table 5 Coefficient Calculation

Efficiency	Coef 1	Coef 2	We	Q	C	$C^{2/3}$	a	b
60%	3.85	10^7	1.7857	1059.44	37438.6	1119.13	3.4933	0.0365
40%	3.85	10^7	1.4884	635.67	1796.44	147.78		

4. Conclusions and Recommendations

The results showed that CO_2 concentrations before the adsorption for 2 stroke and 4 stroke type were 113.705 mg/l and 146.739 mg/l respectively. CO_2 concentration with the length of AC column of 30, 25, and 20 cm, after the adsorption process, their efficiency for the 2 stroke type were 113.137 mg/l and 50.89%; 100.851 mg/l and 24.57%; 65.668 mg/l and 20.35% respectively; as for the 4 stroke type were 116.875 mg/l and 67.35%; 56.145 mg/l and 61.73%; 47.969 mg/l and 20.35% respectively. A maximum adsorption efficiencies for the 2 stroke (50.87%) and the 4 stroke bikes (67.35%) occurred at 30 cm of AC column which was the maximum adsorbent length, where the gas was still capable of passing through the adsorbent column. Based on an adsorption theory, for a ventilation system on the other hand, the length required to reach 90% efficiency was 120 cm. It is recommended that further research should be conducted for the feasibility of the application of adsorption systems for motorbikes and any other combustion facilities.

5. References

McDermot,H., 1979. *Handbook of Ventilation for Contaminan Control.* Ann Arbor : Ann Arbor Science Publisher.

Ruthven, M.D.1984. *Principles of Adsorption and Adsorption Processes.* New York: AWiley-Interscience Publication.

Seinfield, John H.1986, Atmospheric Chemistry and Physic of Air Pollutin. John Willey n Sons

Stern, C.A., 1985. *Fundamental of Air Pollution Control.* London : Academic Pres Inc.

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Rehabililitation Mining Site in PT. X

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Abstract
Natural resource utilization through mining provides a substantial contribution on human welfare. One of general mining activity is an open pit mining system. Such mining activities affect soil and vegetation ecosystem, causing a quality reduction in physical, chemical, biological and sosio-cultural aspects. To prevent these potential negative impacts, it is required to take strategic steps as preventive actions. This activity is known as rehabilitation of mining site, aiming to return the function of such a location to its former condition before its utilization. PT X is mining company in Pulau Sumbawa mines copper and gold using an open pit method. Rehabilitative efforts had been carried out by PT. X ini accordance with the needs of land utilization. Such rehabilitative activities include reclamation, revegetation, monitoring and maintenance as well as reclamation supportive activities as such nursery and tree phenology. This research aim to evaluate the rehabilitation activities of PT. X using observation, effective regulation and theoretical design methods. The result showed that PT. X has successfully planned and implemented rehabilitation activities in accordance with The Decree of Forestry and Plantation Minister Number 146/kpts/-II/1996. In order to support the success of this rehabilitation efforts it is urgently needed local community be involved, so they can obtain information and skill to create ever lasting survival within such rehabilitative site.

Keywords : mining, reclamation, revegetation.

1. Introduction

One of general mining activities is an open pit mining system. This system digging, unloading and transportation using equipments of mine as the method to get mining product. Mining activities affect soil and vegetation ecosystem, causing a quality reduction in physical, chemical, biological and social-cultural aspects. For temporary or continuation duration, degradation of environment quality could be disturbing balance ecosystem . To prevent these potential negative impacts, it is required to take strategic steps as preventive actions. . This activity is known as rehabilitation of mining site, aiming to return the function of location to its former condition before its utilization.

The mining products in PT. X (called Batu Hijau Project in Pulau Sumbawa NTB) are copper and gold . Land rehabilitation, have been done based on land benefit in line with mining activity. Land/site already mined is not going to explore again, but it have to rehabilitated to take care equilibrium condition. In generals , programs to manage land rehabilitation in Batu Hijau project are reclamation, revegetation , monitoring and maintenance and also nursery and tree phenology

The aim of the research is to evaluate rehabilitation activities in PT. X using observation, effective regulation and theoretical design methods and also to get rccommendation to improve land rehabilitation effort.

2. Research Method

2.1. Field Survey :

The purpose is to get illustration about location, condition, and rehabilitation activities in Batu Hijau Project

2.2. Literature Study :

As a guidance and supporting the research. The literature are books, text book, journal, and any other sources from internet.

2.3. Data Collection : Primary data and secondary data.

a. Primary data : is obtained from observation, interview and discussion with operators , employees, and engineers. This process contain land rehabilitation activities suc as method, type and also specification of regulation which applied in PT. X .

b. Secondary data : is obtained from public data in PT. X. This data contain wide of mining land, reclamation wide area, amount of conservation soil and planted location of trees for land rehabilitation.

2.4. Data Analysis : is to evaluate method and equipment which applied in rehabilitation land by elaborating effectiveness and also to evaluate applied regulations in Indonesia

2.5. Conclusion and Suggestion

3. Result and Discussion

3.1. Reclamation

The aim of reclamation is to stabilize the land. Reclamation in Batu Hijau project divided in three (3) activities. There are land analysis, land construction and erosion control installation.

a. Land analysis. Samples have to be analyzed to know the substances of them. Table 1 shows result soil sample for subsoil and topsoil and Figure 1 shows activity of land analysis.

Table 1 Determination Criteria Subsoil and Topsoil

Parameter	Acceptance Interval	
	Subsoil	Topsoil
Total Copper	≤ 900 ppm	≤ 500 ppm
Net Carbon value	≥ -0.01 %	≥ -0.01 %
pH	> 5	> 5
Gravel Percentage	5 - 35	0 – 25
Sand Percentage	10 - 60	10 – 60
Fines Percentage	30 - 75	30 – 85
Plasticity index	5 - 35	5 – 35

Source : Revegetation Techniques 2H : 1V Slopes for Final Reclamtion May 2005, PT. X

Figure 1 Land Analysis Activity

b. Land construction is divided in three phase, they are :

1. Subsoil location phase

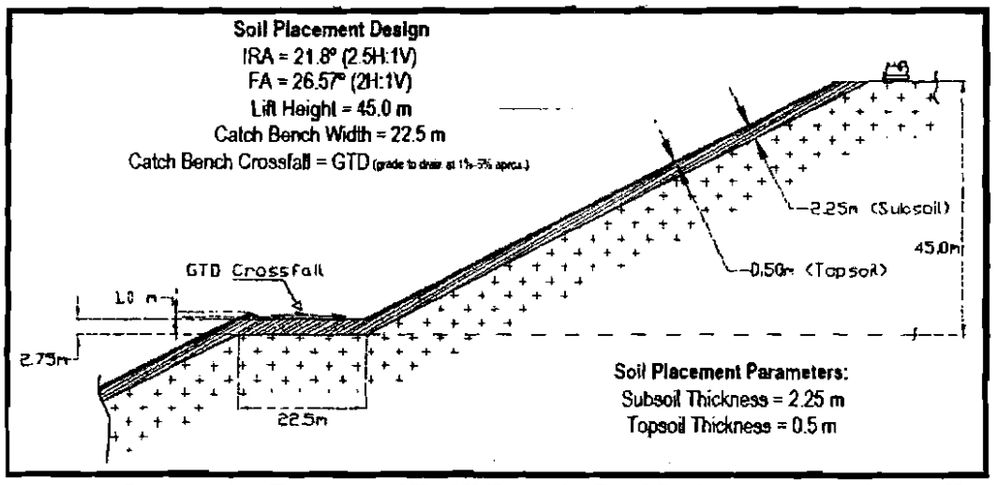
This process started with transportation and spreading of soil land. They using haul truck, then land soil disseminated again in flatten to all part of land by using excavator. The next process is to compact the soil using sheep foot roller . This process has to be done in every layer subsoil and in every time after compaction process. This phase will be checked by the supervisor team to fulfilled the criteria. After that compaction process will be done for the next layer. Total thickness of subsoil is 2,25m and usually divided become 4 layers and every each thickness layer : 75, 50.50 and 50cm.

1. Topsoil location phase

Overall the process of this phase is just the same from previous phase , the difference is in this phase the compaction process use track dozer and only consisting of one layer. Thickness of layer topsoil is 0,5m.

2. Drainage Channel

Roadside channel (drainage channel) is made to control run off water at reclamation area and as sediment trap. The design is made according to contour with deepness 1 m , wide 3 m and inclination of channel wall is 2H: 1V. The sewerage through into contact drain and end in a pond. Drainage channel construction made by material concrete. To manage run off water from mining area outside its built run off sewerage at external boundary of area mined. The purpose is to separate run off water from outside area and water in mining location. This sewerage built in external boundary of mining area and through in to river. The design has wide 6 m, deepness 2.5m with inclination of channel wall is 1.5H : 1V. Material concrete is not used in this construction, but only entrenchment land with sprayed by seed grassing (hydroseeding). Final reclamation construction are fill and slope which recontour by two types, The first type is 3 : 1 with gradient of angle of equal to 18,3° and the second type is 2 : 1 with gradient of angle of equal to 26,6° (figure 2)



Source: Revegetation Techniques 2H : 1V Slopes for Final Reclamtion May 2005, PT. X

Figure 2 Soil Placement Design

c. Erosion Control Installation : Erosion control installation which applied in Batu Hijau project is using java wood. This installation is planted by row (row sprigging) according to contour with planted space about 15 cm and row interval about 15 m. The distance from top slope is 15 m combined with ijuk blankets as sediment filter an jute net for mulch covering soil.surface

3.2. Revegetation

The purpose of revegetation is to reflated native species which is natural vegetation in location and to bringing back the function of such a location to its former condition before its utilization, so the stability of environment would be safe for a next period.

Activities of revegetation are :

a. Hydroseeding : Hydroseeding is one of revegetation step by spraying grasses seeds which have been mixed with other materials. This has to be done for the ex-mining land or a land which required to be taken care due to the stability. High pressured pump at hydroseeer vehicle used for hydroseeding activity. The purpose of hydroseeding is to take care the stability of surface land and to prevent erosion by composing grass layer at the land surface.

b. Seed Plantation : The purpose is to compose new vegetation and to bringing back the condition of land to its early condition and also to take care the stability of land and to prevent the run-off due to reclamation process . Seed plantation is done at a land which have ready for cultivation and usually done at the rain season. Manual technique by making planting hole with dimension at 30x30x30cm with a plant spacing is 2x3m is used as cultivation method. Seed which being planted is divided in to 2 categories . (1) seed having ability of relative quickly grow (1-2 year) (2) seed having ability of slowly grow (fast and slow glowing tree).Figure 3 shows seed plantation activity

Figure 3 Seed Plantation Activity

3.3. Monitoring and Maintenance

The purpose monitoring and maintenance is to know the progress of reclamation and to maintain reclamation site.

a. Monitoring : The purpose of monitoring is to know progress and efficiency of reclamation and to identify locations which requiring additions treatments. The result of monitoring process is taken as matter consideration to determine next step. Land monitoring divided in two ways . (1) plot quadrant technique and (2) rod laser intercept technique . Plot quadrant done by making plot in field 5 x 5 m then counting the material and species in the plot . Rod laser intercept is done by using laser pointer, where counting the enumeration of material and species is done in area of around which hit by its laser pointer. Monitoring activities are covering vegetation and basal, observing earthflow area, and seeing variance of plan type.

b Maintenance : activity of maintenance divided in two main activities, such as planting maintenance 'and erosion repairing . Planting maintenance is doing replanting to plants seeds and fertilize in periodical times. This activity also doing controlling the weeds which can be potential to disturbing plant to grow. Erosion repairing is done at reclamations land where the erosion area happened . This technique consisting of several types based on the damage of erosion land. The technique are energy billows technique, fibre of ijuk, brush layering, bamboo lattice, combination of billows energy, fibre of mulch ijuk and cultivation of grass vetiver.

3.4. Supporter Reclamation Activities

Nursery and tree phenology are supporter reclamation activities which has been doing in this site.

a. Nursery : The purpose of nursery is to deliver seeds which will be used in revegetation. Nursery divided in three phases. They are :

1. Plant material collection : The purpose is to get plant material which will be made for seeds at nursery facilities. Materials which collected at this activity are: seed, and bar cutting from original species in that area.
2. Seed production : Activities of seed production are preparation for media, seed and cutting, treatment and evacuation seed in to polybag. Technique of seed production which applied in Batu Hijau project are seed germination technique, bar cutting technique, and transplantation technique . Multiplication process is done in nursery house whith 60.000 seed capacities and the intensity about 50 - 60 %. Multiplication through germination done in germination house.
3. Seed maintenance : Activities of seed maintenance are watering plants, fertilizing plants and controlling plants from disease, monitoring growth transplation and selecting healthy plants. Organic fertilizer use to fertilize this plants . The control of weeds is done by cleaning weed in plant area. Watering is done 2 times, in the morning and afternoon. Activities of growth monitoring are making a note about high plants, stalk diameter and wide of canopy. To get good plant, we should take healthy plant to be planted in field. Figure 4 shows result of seed production.

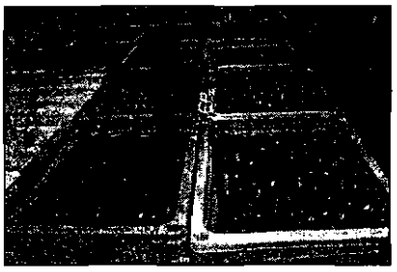


Figure 4 Result of Seed Production

b. Tree Phenology : The aim of tree phenology is to know plant reproduction, life cycles pattern in Batu Hijau area and also to know specific character of them. The activity is done in periodical time at certain locations in order to know the conditions in locations of Batu Hijau area. Growing of flower, seed , fruit and general plants condition are parameters that should be observed and noted to fulfilled with the parameters criteria.

3.5. Regulation and Implementation

Minister Forestry and Plantation Degree No. 146/kpts –II/99, on 22 March 1999 explained thatenergy and mining company whose doing mining activity in forest area have obligation for

1. Doing reclamation for ex mining land
2. Responsible for reclamation cost
3. Have properly organization to manage reclamation program
4. Doing protection programs to protect the forest which had borrowed for mining activity.

Implementation of land rehabilitation in PT X generally included fourth point obligation. Those obligations are implemented in special division of reclamation in environmental department, and it done according to the responsibility.

Minister Forestry and Plantation Degree No. 146/kpts –II/99, on 22 March 1999 also explained that scope of reclamation are :

a. Investment reclamation location
b. Determination reclamation location
c. Reclamation planning

d. Reclamation implementation divided in some activities. They are :
   1. Field/ land preparation
   2. Arrangement land type
   3. Controlling erosion and sedimentation
   4. Top soil treatment
   5. Revegetation
   6. Maintenance

Fund reclamation guarantee is one of investment activity that has been done by PT. X. Determination reclamation location and reclamation planning is been done in periodical time and explained in implementation reclamation report, and after that evaluated by government. All activities which implemented for land rehabilitation based on SOP (Standard Operating Procedure) . SOP is a guidance and regulation to explain basic activity in properly.

Minister Forestry and Plantation Degree No. 146/kpts –II/99, on 22 March 1999 also explained that success definition for reclamation activity is fulfilled with criteria of arrangement land type, erosion & sedimentation controlling, and revegetation .

Figure 5 shows rehabilitation land location , the result from implemented rehabilitation activities according with The Decree of Forestry and Plantation Minister Number 146/kpts/-II/1996 .

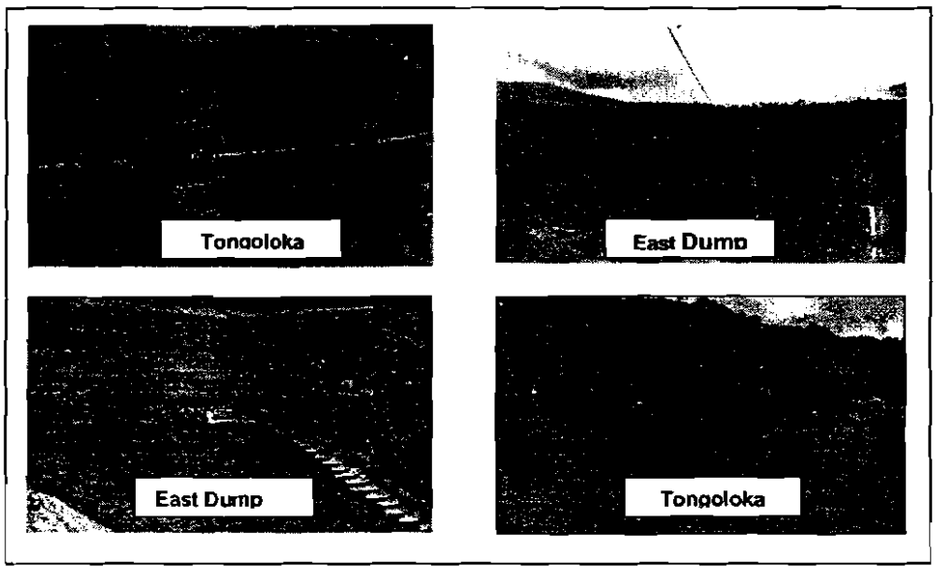


Figure 5 Rehabilitation Land Location

4. Conclusion

1. PT. X have successfully done land rehabilitation activities according to criteria of mining land in minister forestry and plantation degree No 146/kpts-II/99 on 22 march 2009 about reclamation guidance.
2. Government institution take part as supervisor and observer according to their responsibility based on Minister Forestry and Plantation Degree No. 146/kpts –II/99 in land rehabilitation at PT. X.
3. In order to support the success of rehabilitation, it is urgently needed local community to beinvolved, so they can obtain information and skill to create ever lasting survival within such rehabilitative site.

5. References

Haryadi, Agus. 2003. *Laporan Kerja Praktek : Kegiatan Reklamasi Lahan Tambang Proyek Batu Hijau Sumbawa*. Universitas Padjajaran. Bandung.

LantonI, M. Sholihin. 2004. *Laporan Kerja Praktek : Total Tones Truck Factor dan VIMS. Universitas Islam Bandung*. Bandung.

PT. X. 1998. *Laporan Utama : Studi Analisis Dampak Lingkungan (ANDAL) Terpadu*. PT.x. Sumbawa.
PT. X. 1998. *Rencana Pengelolaan Lingkungan (RKL) Pertambangan Tembaga dan Emas, Batu Hijau Dati II Sumbawa Propinsi NTB*. PT. X. Sumbawa.
PT. X. 2005. *Technical Instruction Soil Placement on 2H 1V For Final Reclamation*. PT. X. Sumbawa.
PT. X. 2003. *Paradigma Baru Dalam Industri Tambang*. PT. X. Sumbawa.
Suripin. 2001. *Pelestarian Sumber Daya Tanah dan Air*. Penerbit Andi. Yogyakarta.