Proceeding

The 4th ETMC 2011

"Present and Future Challenges in Environmental Sustainability"

2011 ENVIRONMENTAL TECHNOLOGY AND MANAGEMENT CONFERENCE

November 3 – 4, 2011

Bandung, Indonesia

ISBN 978-979-98278-3-8

Published by
Faculty of Civil and Environmental Engineering
Institut Teknologi Bandung - Indonesia

Please cite any paper(s) in this proceeding by including following information:

[Name of author(s)], *[Title of paper]*, Proceeding The 4th Environmental Technology and Management Conference: "Present and Future Challenges in Environmental Sustainability", Indonesia, 2011.

PREFACE

Sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs should be implemented in all countries. The implementation is of importance especially with the presence of alarming local to global scale anthropogenic environmental problems and how the countries are connected through the earth‘s natural system. It is thus imperative that countries collaboratively working together to tackle and prevent the problems in order to warrant the successful implementation of sustainable development in the countries.

It is under the above mentioned spirit that the Environmental Technology and Management Conference (ETMC) was initiated. Held every 4 years since 1997 and with growing numbers of participant and expertise, the ETMC brings together policy makers, scientists, engineers, industries, and field expertise in environmental technology and management to discuss current and future local, regional, and global environmental issues. The ETMC is aimed to provide a forum to discuss and disseminate advances in research, technologies, and management, for improving the quality of the environment. Past participants of the conference include researchers, academic staffs, students, industries, public, and government officials.

With theme "Present and Future Challenges in Environmental Sustainability", the 4th ETMC is a global momentum for sustainable development that will lead to practical applications of the engineering and science of sustainability. Participating industries, academics, and governmental bodies will acquire information on the state of the art in environmental technology and management.

Plenary sessions of the 4th ETMC include presentations by:

- **Prof. Toshihiro Kitada**
  Toyohashi University of Technology, Japan
- **Prof. (Hon) Rachmat Witoelar**
  President's Special Envoy for Climate Change Indonesia.

There are invited international distinguished speakers:

- **Prof. Yen Peng Ting**
  National University of Singapore, Singapore
- **Prof. Rudy Sayoga**
  Institut Teknologi Bandung, Indonesia
- **Prof. Naoyoki Funamizu**
  Hokkaido University, Japan
- **Prof. Michael Sturm**
  FH Köln, Germany
- **Prof. Kim Oanh**
  Asian Institute of Technology, Thailand
- **Prof. Takeshi Fujiwara**
  Okayama University, Japan

- **Ir. H. Mulyadi Afmar**
  PT. Benefita, Indonesia
- **Moekti Handajani Soejachmoen**
  Special Assistant to the President's Special Envoy for Climate Change Indonesia
- **Dr. Setiawan Wangsaatmadja**
  Environmental Management Agencyof West Java, Indonesia
- **Dr. Indra Budiman Syawmil**
  Institut Teknologi Bandung, Indonesia

Contributed oral (114 contributions) and poster (26 contributions) presentations are divided into 6 major sessions:

A. Eco-industries
B. Natural Resources Management
C. Water Resources Management
D. Environmental Engineering and Technology
E. Green Cities
F. Climate Change and Air Pollution

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

Bandung, November 2011

Ir. Edwan Kardena, PhD
Chair of Organizing Committee

LIST OF COMMITTEES

ORGANIZING COMMITTEE

Chairman : Dr. Ir. Edwan Kardena

Vice Chairman : Emenda Sembiring, ST, MT, M.EngSc, Ph.D

Secretary : Ir. Arief Sudradjat, MIS, Ph.D

Sponsorship : Dr. Benno Rahardyan, ST, MT
Dr. Asep Sofyan, ST, MT

Publication : Dr. Mochammad Chaerul, ST, MT

Treasurer : Dr. Ir. Dwina Roosmini, MS
Dr. Kania Dewi, ST, MT

Program : Herto Dwi Ariesyady, ST, MT, Ph.D
Dr. Ir. Katharina Oginawati, MS
Dr. Ing Marisa Handajani, ST, MT
Dr. Sukandar, S.Si, MT

Logistic : Dr. Qomarudin Helmy, ST, MT

Website : Rofiq Iqbal, ST, M.Eng, Ph.D

SCIENTIFIC COMMITTEE

Chairman : Prof. Dr. Ir. Wisjnuprapto

Secretary : Prof. Dr. Ing. Ir. Prayatni Soewondo, MS

Members : Prof. Dr. Ir. Enri Damanhuri
Prof. Dr. Ir. Arwin Sabar, MS
Dr. Ir. Tri Padmi Damanhuri
Prof. Ir. Suprihanto N, Ph.D
Ir. Pudji Lestari, Ph.D
Dr. Sri H. Suhardi
Ir. R. Driejana, MSCE, Ph.D
Dr. Ir. Mindriany Syafila, MS
Dr. Ir. Priana Sudjono, MS, Dipl.Eng
Idris Maxdoni Kamil, M.Sc, Ph.D
Dra. Barti Setiani Muntalif, Ph.D
Ir. Agus Jatnika Effendi, Ph.D

CONTENTS

PREFACE i

LIST OF COMMITTEES iii

PLENARY LECTURES

Prof. Toshihiro Kitada – Modeling for a Sustainable Environment: Sustainable Environment System and Urban-Regional-Global Atmospheric Environment ....PL 1

Prof. (Hon) Rachmat Witoelar, Indonesia) – Climate Change: A Global Issue Beyond Environmental Problem ....PL 2

INVITED SPEAKERS

Prof. Yen Peng Ting – From Biomining of Mineral Ores to Bio Urban Mining of Industrial Waste ....IS 1

Prof. Naoyoki Funamizu – New Policy for Water and Sanitation System – Resources Oriented Sanitation System ....IS 2

Prof. Michael Sturm – New Challenges in Wastewater Treatment in Germany IS 3

Prof. Kim Oanh – Co-control for Air Quality and Climate Benefit: Opportunities for Asia ....IS 4

Prof. Takeshi Fujiwara – Planning and Evaluation of 3R-based Solid Waste Management ....IS 5

Dr. Setiawan Wangsaatmadja – The Use of SWAT (Soil & Water Assessment Tool) To Analyse Runoff Pattern Caused by Land Use Change in Upper Citarum Area ....IS 6

Dr. Indra Budiman Syawmil – Social Construction view of the Green City Concept ....IS 7

Moekti Handajani Soejachmoen – Bettering Air Quality whilst Combating Climate Change ....IS 8

Ir. H. Mulyadi Afmar – PROPER and Green Industry Award Toward Eco-Industry in Indonesia ....IS 9

Prof. Rudy Sayoga Gautama – Challenges in Environmental Management in Indonesian Mining ....IS 10

ORAL SESSION SPEAKERS

Session A – Eco industries

Hathairath T. Wattanaphon – Influence of Co-substrate and Nitrogen Source on Polyhydroxybutyrate Production .... EI 1

Wahyu Bahari Setianto – Recovery of The Lost Palm Kernel Oil in Palm Kernel Cake Using Supercritical Carbon Dioxide .... EI 2

Nugroho Adi Sasongko – Improving Efficiency of Coal Combustion by Circulating Fluidized Bed Combustion (CFBC) Technology .... EI 3

Haryo S. Tomo – Retrofit Study to Optimize Fuel Usage and Reduce Air Pollution in Medium Scale Quicklime Production (Case Study: Quicklime Industry in Padalarang, Bandung)... EI 4

Kania Dewi – Optimizing Physical and Chemical Factors during Limestone Dissolution for Abrsoption of SO_2 from Coal Fired Power Plant....................... EI 5

Turmaningsih Surya Pratama – Correlation Analysis of The Age and Exposure Periode with Hearing Capabilty Based on Audiometric Test Result of Employees in Production Unit Central Processing Area Job P-PEJ Tuban JawaTimur .... EI 6

Nassereldeen Ahmed Kabbashi – Process Optimization for Bioethanol Production from Molasses .... EI 7

Hendro Risdianto – Optimisation of Laccase Production Using White Root Fungi and Agriculture Wastes in Solid State Fermentation .... EI 8

Nila Wildani – Preliminary Study of Sandblasting Waste Utilization for Al & Fe Coagulant Based .... EI 9

Cheerawit Rattanapan – Comparison of Coagulant Types for Pre-treatment of Biodiesel Wastewater .... EI 10

Velma Nindita – The Minimization of Waste through Eco-Efficiency Design of Raw Materials, Water, and Energy on Small and Middle Scale Industry (Case Study: UKM Nadia Royani in Simbang Kulon, Buaran District, Pekalongan Regency)... EI 11

Ayu Mutiara Hapsari – Immobilization of Detergent Degrading Bacteria in Trickle Bed Reactor for Detergent industrial Effluent Removal: Linear Alkylbenzene Sulfonate .... EI 12

Dyah Wulandari Putri – DMSO Biodegradation Mechanism and DMSO/DMS Degrading Bacteria Community Responses in TFT-LCD Wastewater Treatment Process .... EI 13

Werdi Putra Daeng Beta - Implementation of Dose Constraint Concept in Industrial Radiography to Ensure Safety and Health of Public, Workers and Environment .... EI 14

Rubia Binti Idris - Comparative Study on Removal Cd2+ and Pb^{2+} via Biosorption Using Red Seaweed *Kappaphycus sp.* .... EI 15

Elizabeth Dionasari – Absorption of Heavy Metal Chromium (Cr) by Freshwater Mussel *Anodonta Woodiana* in Electroplating industry Wastewater (Case Study: Pt X) .... EI 16

Norhashimah Morad – Phytoremediation of Wastewater Containing Nickel and Copper Using Water Hyacinth .... EI 17

Ali Pramono - The Cr(VI) Reduction Potential of *Agrobacterium sp.* .... EI 18

M. Ibrahim Ats-Tsauri - TOME (Tunneled-Dome) Bio-digester, a Baffled Bio-digester Perfected for Tofu Industry Waste-Water Treatment .... EI 19

Edi Iswanto Wiloso - The Use of Life Cycle Assessment for Second Generation Bioethanol .... EI 20

Desak Nyoman Inten Apriani - Utilization of Spent Catalyst Waste for Mixed Paving Block and Concrete Bricks .... EI 21

Stepan Bohus - Effective Secondary Raw Material Usage in Progressive Building Materials .... EI 22

Session B – Natural Resources Management

Sri Handoyo - Geospatial Information of The Joint River and Water Management along The Land Border between Indonesia and Timor-Leste .. NRM 1

Sri Hayyu A. Heryati - Coastal Waste Management at Jakarta Bay and The Seribu Islands .... NRM 2

Anita Ulifah - Community Structure of Mangrove Crab in Mangrove Area at Surodadi, Sayung, Demak .... NRM 3

Maryam Mohammadi Roozbahani - Studies on the Benthic Macroinvertebrates Diversity Species as a Management Tool of Environmental Health in Bahrekan Bay (Northwest of Persian Gulf) .... NRM 4

Lalita Fitrianti - The Use of Bryophytes' Biodiversity as an Indicator to Environmental Changes in Mount Tangkubanparahu, Indonesia .... NRM 5

Huda Nurjanti Suryanto - Agrotourism Area Design In Tin Post-Mining Land, Bangka .... NRM 6

Raghvendra Pratap Narayan - Effect of Modern Agricultural Practices on Population Size of Azotobacterchroococcum and on Its Nitrogen Fixing Potentiality in Trans–Ganga and Trans-Yamuna Plains of Allahabad (India) .... NRM 7

Weling Suseno - Remote Sensing Application Using NOAA-18 AVHRR Satellite Image for Extracting Agricultural Drought Pattern in Java Island .. NRM 8

Napaporn Leadprathom - The Survey on Pesticide Use in Tropical Fruit Orchard for Environmental Management; Case Study in Chanthaburi River Chanthaburi Province Thailand .... NRM 9

Priana Sudjono - The Fate of Organophosphate in Steep-Sloped Agriculture Soil under The Influence of Runoff Generation .... NRM 10

Suphia Rahmawati - Organochlorine Pesticides Residue in Fish of Upper Citarum River, West Java Indonesia: Distribution and Their Health Risk Assessment .... NRM 11

Napaporn Leadprathom - The Screening Ecological Risk Assessment for Pesticides in Chanthaburi River Water Chanthaburi Province Thailand ..... NRM 12

Tri Wahyuni - Accumulation and Depuration Copper (Cu) and Zink (Zn) in Tilapia (*Oreochromisniloticus*) Using Chelation Agent Na2EDTA and *Chlorella* sp. .... NRM 13

Dita Amalia - The Effect of Different Breeding Sources on Zinc (Zn) Accumulation and Elimination on Nile Tilapia (*Oreochromisniloticus)* ..... NRM 14

Chefin Suprian - Accumulation of Mercury (Hg) in Fish on Cage Aquaculture and Wild Fish at Jatiluhur Reservoir .... NRM 15

Tomi Rustamiaji - Multifactorial Experiment of Pb (II) and Cu (II) Bioaccumulation on *Oreochromisniloticus* with Concentration and Temperature Variance (Reference: Cirata Dam Condition) .... NRM 16

Heny Suseno - Study of Bioaccumulation Inorganic Mercury by Green Mussel (*Pernaviridis*) from Jakarta Costal Bay Using Radiotracer .... NRM 17

Anggia Retno - Constructed Wetland Application in Septic Tank Effluent Treatment .... NRM 18

Agus Slamet - Remediation of The Boezem Water Which Contaminated by Urban Wastewater Using The Cultivation of Algae (Case Study: Boezemin Surabaya City) .... NRM 19

Yunus Shukor - Bioassay of Xenobiotics Using the Multiple Xenoassay® System .... NRM 20

Session C – Water Resources Management

Tengku Fazli Tengku Yahya - TMDL as Solution in River Management System: Case Study in Merlimau River Malacca, Malaysia .... WRM 1

Dyah Marganingrum - Optimization of Reservoir Operation with Continue Model to Meet the Fresh Water Demand Rate and Face Hydrological Regime Change (Case Study: Saguling Reservoir-West Java, Indonesia) .... WRM 2

Ika Rahmawati - Water Resource Management Model for Eco-Industrial Park (Case: Jababeka Industrial Park Phase I, Bekasi Regency) .... WRM 3

Basavaraj Hutti - Water Resources Management using Geoinformatics Tools and Applications in North Karnataka, India .... WRM 4

Ariani Budi Safarina - Study of Variation Temporal and Spatial Distribution of Rainfall on Various Watersheds Topography and The Influence On Flood Discharge Estimation .... WRM 5

Luki Subehi - Identification of Land Use Changes that Influenced Discharge Pattern at Cisadane Upstream Watershed .... WRM 6

D. Erwin Irawan - Satellite Image Processing of Bandung Area to Simulate Zero Artificial Runoff .... WRM 7

Zarina Md Ali - Roughness Characteristics of Unlined Parit Karjo............ WRM 8

Janice Lynn Ayog - The Investigation of Existing Water Supply Problems and Solutions in Banggi Island, Malaysia .... WRM 9

Erwin - Analysis of Hydrological Regime as Instrument Control Land Use Watershed (Case Study Cimanuk Watershed Upstream of West Java Province) ....WRM 10

Lieza Corsita - Effect of Increased Diversity on the Hydrological Regime Phytoplankton and Water Quality in Aquatic Ecosystems in Reservoir Kaskad ....WRM 11

Sri Puji Saraswati - Study on River Water Quality Status of Bedog River Yogyakarta by Using One–dimensionsional Numerical Simulation ....WRM 12

Nur Asmaliza Mohd Noor - The Effect of Water Quality Before and After Sungai Muda Flood Mitigation Construction using QUAL2E Model ....WRM 13

Rifat Quamrul Alam - A Study on Impact of Environmental Degradation on The Water Quality of Turag River System ....WRM 14

Cindy Rianti Priadi - The Importance of Solid Metal Speciation in Addressing Water Quality Issue – Study Case in The Seine River ....WRM 15

Wilda Naily - Groundwater Contamination Index in Cicabe Waste Disposal Site ....WRM 16

Andre Wiguna - Identification Bacteria of Groundwater by Cultured Analysis and 16S rRNA Genes Clone Used in Surrounding Area of Landfill Cicabe – Bandung ....WRM 17

Rima Septisia - Contingent Valuation Methods Application To increase Water Quality in Siak River Pekanbaru ....WRM 18

Gatut Sudarjanto - Decolourization of Effluent Containing Spent Molasses by Means of The Photochemical Method as an Attempt for Water Reuse: Process Optimization Using Response Surface Methodology ....WRM 19

Aini Rinarti - The Effect of Aeration and Reactor's Media Thickness in The Organic Removal of Bojongsoang WWTP's Effluent Using Horizontal Subsurface Flow in a Constructed Wetland ....WRM 20

Session D – Environmental Engineering and Technology

Ellina S. Pandebesie - Influence of Microorganism Added on Domestic Solid Waste Composting .... EET 1

Warmadewanthi - The Effectiveness of Water Hyacinth for Removing of Salinity from Municipal Landfill Leachate .... EET 2

Warmadewanthi - The Effect Saline Leachate Recirculation on Solid Waste Degradation Rate in TPA Benowo, Surabaya .... EET 3

Luhur Akbar Devianto - The Effect of Increasing Glucose Concentration in Biosurfactants Production by *Azotobactervinelandii* and Its Potential Application .... EET 5

Riza Oktavianus - Oil Sludge Bioremediation Using Biopile Technique and Microbial Consortia Innoculation with Ramei *(Boehmerianivea (L.) Gaud.*) as Bio-Indicator Plant .... EET 6

Norli Ismail - Reduction of Oil and Grease from Kitchen Wastewater by Compost Tea .... EET 7

Etih Hartati - Degradation of Biowaste Liquid Fraction Vegetables and Fruits in Anaerob Batch Reactor .... EET 8

Kurniasih - Chromium (VI) Biosorption by Immobilized Phytoplanktonic Consortium .... EET 9

Thiwari Ophithakorn - Reduction of Organic Matter in Stabilization and Free Water Surface Constructed Wetland of Hat Yai City Municipality, Thailand .... EET 10

Doni Sugiyana - Photocatalytic Degradation Performance by Multiple Reuse of TiO2 Nanofibers Based Composite Catalysts for Textile Dyeing Wastewater Treatment .... EET 11

Mohd Asri Mohd Nawi - Photocatalytic Degradation of RR4 Azo Dye by Immobilized PANI/TIO2/ENR/PVC Composite under Low Energy Compact Fluorescent Lamp Light Source .... EET 12

Lelifajri - Photocatalytic Removal of 2,4-Dichlorophenoxyacetic Acid Herbicide Using Immobilized TiO_2 System on Glass Plate .... EET 13

Sumiyyah Sabar - Immobilized TiO_2/Chitosan Layer by Layer System Modified with Reactive Red 4 Dye for The Photodegradation of Phenol ..... EET 14

Noor Nazihah Binti Bahrudin - Removal of Phenol via Immobilized TiO2/AC Layer by Layer System .... EET 15

Sirikul Siriraksophon - Characteristic of DOM in Raw Water Source from Reservoir and Evaluation of Treatment Efficiency Using Hybrid Nanofiltration Process .... EET 16

Gatut Sudarjanto - Investigation of The Possible Toxic Effects of The Advanced Chemibiological Treatment of a Reactive Azo Dye .... EET 17

Ratna Budiarti - Immobilization of Pillared Clay Containing Rafinat Waste from Molibdenum99 Production by Polymer .... EET 18

Woro Nastiti Utami - The Study of Antiscalant and Cleaning ProcessonNanofiltration Membrane .... EET 19

Session E – Green Cities

Budi Setiawan - Sorption Characterization of Radiocesiumby Host Rock of Candidate Site as Reliability Indication of Radioactive Waste Disposal Site ...GC 1

Fazlur Hassan - Shortest Distance for Municipal Solid Waste Transportation using Geographical Information System (Case Study: Northern Bandung City) .... GC 2

Yulinah Trihadiningrum - Public Participation in Residential Solid Waste Management in Surabaya City, East Java Province, Indonesia .... GC 3

Wulan Desika Fajri - Preliminary Study of Noble Metal (Gold) Recovery Process from Electronic Waste (E-Waste) Components Conducted by The Informal Sector (Case Study: City of Bandung) .... GC 4

Kengo Nakamura - Study on The Method of Reducing Fluorine Dissolution through The Process of Steel Slag as Recycling Material ....GC 5

Mohd Azlam Majid - Capital and Consumption-led Growth: Case Study in Malaysia, Singapore, Japan and Zimbabwe ....GC 6

Mekar Sari Suteja - Form-Based of Smart Infrastructure Codes, The Green Strategic Ideas of City Planning .... GC 7

Rizki Tridamayanti Siregar - Operational Energy Assessment of Aerated Concrete as a Building Material for Low Cost Housing ....GC 8

R. Wira Prasetya - Green Roof Potential Application as a Part of Sustainable Drainage System in Urban Area (Case Study: Bintaro, Jakarta) ....GC 9

Niyazi Çetynkaya - A Fuzzy Analytic Network Process (ANP) Approach for Final Disposal Process Comparison of End-Of-Life Tyres: The Case of Turkey ....GC 10

Benno Rahardyan - Economic Evaluation for Assessing Positive Perception Toward MSW Landfill Improvement ....GC 11

Mochammad Chaerul - Healthcare Waste Management in Bandung City, Indonesia and Its Recommendation for the Improvement ....GC 12

Pawit Chaivisit - Fungi and Bacteria Contamination in Intensive Care Unit in University Hospital: Efficacy of Protective Measures ....GC 13

Nandia Gresita Trinanda - Analysis of Microbial Air Quality at Composting Facility in City of Depok, and The Impact to Human Health ....GC 14

Thunwadee Tachapattaworakul Suksaroj - Nutrients Leaching from Waste Latex Sludge and Its use for Planting Material Production ....GC 15

Nindi Sekarsari - The Effect of Turning Frequency on Compost Quality Using Open Windrow Method ....GC 16

Session F – Climate Change and Air Pollution

Ganesh Chandra Saha - Recent Trends of Climate Change on Southern Regionof Bangladesh ....CC 1

Djoko Suroso - Climate Change and Human Health: Health Risk Assessment in Great Malang Area, Indonesia ....CC 2

Asep Sofyan - Modeling the Effects of Weather and Climate Change on Malaria and DHF Transmission: Case Study South Sumatera, Indonesia ....CC 3

Ridad Agoes - Climate Variability and Increase in Intensity of Dengue in Tarakan Island, Indonesia .... CC 4

Mila Dirgawati - Correlation and Risk Analysis of Ambient Air Quality to Mortality and Morbidity in Bandung City (A Case Study in Industrial, Heavy Traffic and Residential Area) .... CC 5

Syarif Hidayat - The Characteristics of Urban Park and Urban Forest: Strategy to Mitigate Urban Heat Island .... CC 6

Naveen Danesh - Depletion of Diversity and Pigments of Epiphytic Lichens Due to Climate Change .... CC 7

Dedi Nursyamsi - Use of Ameliorants to Mitigate Greenhouse Gases Emission in Peat Soils of South Kalimantan .... CC 8

Rachmat Boedisantoso - Analysis of Green Open Space as CO_2 Absorber (Case Study: Surabaya City) .... CC 9

Andrisa Pramadityani - Health Effects as Related to Air Pollution, Using Ostro Model in Metropolitan City (Case Study: Tegalega Bandung Area) ..... CC 10

Puji Lestari - Emission Inventory and Spatial Distribution of Air Pollutants (CO, Nox, HC, AND SPM) From Transportation Sector in DKI Jakarta Based on Fuel Consumption .... CC 11

Muhayatun Santoso - Lead Concentrations in Ambient Air from Suburban Site in Lembang, Indonesia during 2005-2007 .... CC 12

Asep Sofyan - Effects of Sea/Land Breezes on Dynamics of Air Pollutant's Mass Budget in Jakarta, Indonesia .... CC 13

Windy Iriana - Measurement of PM2.5 and Carbon Monoxide (CO) Concentrations Emitted From Cooking Activities Using Wood Fuel in Desa Sunten Jaya, KecamatanLembang during Rainy Season .... CC 14

Zulfikar Ali As - Exposure Analysis of $PM_{2.5}$ in Residential Area Around Coal Hauling Road (Case Study: Kabupaten Tapin Propinsi Kalimantan Selatan) . CC 15

Arief Sabdo Yuwono - Dispersion Simulation of Gaseous Pollutants Generated from a Drill Stem Test .... CC 16

Mariana Marselina - SO2 and NO2 Dispersion Simulation Using WRF-Chem Modeling in Bandung City .... CC 17

Kania Mayang Lestari – Evaluation of Precision and Accuracy Passive Diffusion Tube for NO_2 Measurement .... CC 18

POSTER SESSIONS

Dwi Abad Tiwi - Urban Parks as Green Infrastructure Elements to Reduce The Cost of Flood Control: The Case of Jakarta City .... P 1

Liliana Yetta Pandi - Regulatory Framework on Management of Spent Nuclear Fuel from Nuclear Reactor .... P 2

Dewi Aprianti - Influence Analysis of Vehicles Traffic Volume to Total Suspended Particulate (TSP) Concentration and Measurement of Lead Concentration at Cililitan 2 Gate Highway, Jakarta Inner Ring Road, January - February 2011 .... P 3

Mas Agus Mardyanto - Study of The Lapindo Mud as Additive for Making Pervious Paving with Ceramic Fragments for Reducing Runoff .... P 4

Eka Pradana Susanto - Energy Absorption from Air Conditioner by Wall .... P 5

Wiwik D Pratiwi - Resource Management in Traditional Dwelling within Urban Context and The Eco-Cultural Tourism .... P 6

Mohd. Saidin Misnan - Developing Occupational Health and Safety (OHS) Culture Model in Construction Industry .... P 7

Weerawat Ounsaneha - Assessing The Eco-Efficiency among Thai Farmers For Rubber Sheet Production in the Context of Aged Rubber Trees .... P 8

Mahdi Kolahi - Accountability and Development of Protected Areas Management .... P 9

Luki Subehi - Analysis of Rainfall and Landuse Characteristics as The Basis for Cisadane River Watershed Conservation .... P 10

Doli Rionari - A New Emission Dataset for Air Pollutants and GHG in Indonesia .... P 11

Ghoustanjiwani Adi Putra - Human Perception “A Study on The Role of Built Environmental Quality for Human Wellbeing” .... P 12

Kemala Sari - Study of Sediment Discharge and Concentration: Strategy of Land Utilization at Padang Watershed .... P 13

Bhakti Alamsyah - Low Energy Building in Green Architecture Context: Paradigm and Manifesto for Sustainable Future .... P 14

Alia Widyarini H - Finding The Most Appropriate Method of Water Conservation in Indonesia: A Literature Review Study .... P 15

Mohd. Hairy Ibrahim - Tropical Trends of Urban Climatology Changes; with Special References on The Temperature Changes of Ipoh Urban Areas, Malaysia .... P 16

Nur Rahmah Fithriyah - The Study of Tofu Liquid Waste Utilization to Produce Liquid Fertilizer for Plants (Case Study at Tofu Factory at Kenjeran) .... P 17

Prawira Adi Putra - Assessment of Total Suspended Particulate (TSP) and Noise Levels in School Zones (Case Study of Public School in South Jakarta) .... P 18

Muhammad Safri Lubis - Application of Web Based Information Technology for Environmental Data: a Case Study at BLH Pemerintah Kota Medan .... P 19

Asep Sofyan - Effect of Organic and Inorganic Particulates to Corn Crops ...... P 20

Endah Mubiarti - Dominant Bacteria in Biofiltration Top Soil Media for Carbon Monoxide Gas Removing .... P 21

Sri Gustiani - New Technique in Preparation of Bacterial Cellulose (BC) Nanofibers Supported with Silver and Titanium Dioxide Nanoparticles for Removal of Textile Wastewater .... P 22

Katharina Oginawati - Exposure Analysis of Carbon Monoxide (CO), Lead (Pb) and Cadmium (Cd) in Cigarettes Smoke to The Customers of Online Game Center .... P 23

Sri Maryati - Spatial Intervention in Increasing Efficiency of Public Water Supply .... P 24

Yanita Hanastasia - Numerical Simulation of CO and NH3 Using WRF-Chem in Bandung City, Indonesia .... P 25

Yulinah Trihadiningrum - Photocatalysis of Oil Pollutants in Sea Water Using UV Light and Titanium Oxide Catalyst .... P 26

Preliminary Study of Noble Metal (Gold) Recovery Process from Electronic Waste (E-Waste) Components Conducted by The Informal Sector (Case Study: City of Bandung)

Wulan Desika Fajri[1], Sukandar[2], Enri Damanhuri[3]

Environmental Engineering Department, Faculty of Civil and Environmental Engineering
ITB, Ganesha.10, Bandung, 40132
[1]wulan.desfa@yahoo.co.id, [2]kandar@ftsl.itb.ac.id, [3]e_damanhuri@ftsl.itb.ac.id

Abstract Nowadays there are many informal sectors that started recycling business of computer waste which is in the form of used electronic equipment and components that have been damaged. Recycling locations are located in the area of Astana Anyar, Cicaheum, Ahmad Yani, Cileunyi and Banjaran. Recycling is done using the printed circuit board (PCB). On the PCB can be found integrated circuits (IC) containing various metals such as Ag, Au, Cr, Cu, Fe, Mn, Ni, Pb, Sb, and Zn. The main product of this recycling is gold, while the by-products are silver and copper. Gold recycling process is known as a gold smelting process. The stage of the process begins from the separation of IC through burning, milling, smelting, and refining. The materials used in the smelting process are borax, tin and nitric acids while the equipment used are basins, filters, koi, lisum, flat rock and solder. Residues resulting from the smelting process are either simply dumped into drainage channels or potentially recyclable. The waste that can be recycled is the waste in the process of smelting wastes (solid tin slake) by melting it back to get the gold remains and waste from the purification process to obtain silver with the addition of salt and smelting process.

Keywords: informal sector, integrated circuit, recovery

1 Introduction

One of the many types of wastes that is categorized as hazardous wastes is electronic wastes (e-waste). E-wastes generated in Indonesia come from not only domestic usage but also disposals from other countries. Although Indonesia is one of the countries which have ratified Basel Convention about hazardous wastes trans-boundary, in fact the export-import activities of e-product and e-waste still continues illegally.

The attempt of e-waste recycle can also cause problems because of its high risks toward the recycler and its potential of causing poisonous secondary products. Based on preliminary observation of e-waste path flow in Indonesia, the e-waste is not brought directly to the TPA or the centre of 3R, but being reused, recycled, or stripped down (cannibal) in order for their components to be used again [1]. The e-waste recycling in Indonesia occur pretty uniquely and the attention focuses on the e-waste product components is very high so that it will increase the life time, in other words, the end-of-life of the e-waste will be longer [2].

In addition to hazardous and toxic materials, e-waste also contain various kinds of materials that still have high economic value and have the potential to be recycled. Increasing emergence of e-waste encourage the informal sector to do the processing on that type of waste. However, informal sector activities that are carried out cannot be said legal. There are yet regulations governing the activities undertaken related to the informal sector to process the waste. One of the valuable materials that can be recovered from the e-waste is gold, the precious metal with a very high economic value. Currently, recovery activities are still carried out by the informal sector using conventional processes that may be found in a spontaneous process or unconsciously be a new discovery that has not been published.

In developing countries, including Indonesia, it is most likely that the activities required within processes of precious metal recovery, health and environmental problems are not of concern. Based on initial observations in the field, residues or waste generated from this process is directly discharged into water bodies or dumped in the environment (Damanhuri et al, 2008). One of the wastes generated is an acidic liquid waste in which various kinds of heavy metals are concentrated in it.

2 Methodology

This research was conducted to obtain a picture recovery process (recycling) which is done conventionally by the melting e-waste within the city of Bandung. In this study the recovery process and the hazards of waste generated in these processes need to be identified so that wastes can be incorporated into the process to recycle more efficiently and environmentally sound. The survey, conducted as a preliminary survey to identify the e-waste recovery processes in terms of economics.

Preparation; Preparations are made prior to this final task, consisting of collecting data and obtaining information from scientific papers or previous studies about e-waste such as data components of e-waste, e-waste collectors and melting e-waste. ***Preliminary survey;***Preliminary survey is taking directly findings obtained from both methods of data collection, which are through observations and interviews.

Location of e-waste recycling; Survey is conducted to identify locations estimated that there are business e-waste recycling in the city of Bandung. Based on the information on these locations we can see the number and location of e-waste buster to describe the process of recovery of precious metal (gold) of the components of electronic waste.

Identification recovery process; The Recovery processes is taking the economic value of activities of the components of a computer-waste component with a way to dismantle and then further processed to obtain useful metals like gold, copper, and silver thus become material that has more economic value. Thus the steps of recovery process need to be identified.

Waste and hazard identification; Recovery processes involves chemical reactions, so there is the possibility of residue generated as a result of these chemical reactions. These residues are not considered useful therefore they are disposed of as waste, and other components that still have potential economic values are further recycled. Thus it is necessary to identify the possibilities of recycling residues and handling recommendations. The process of recycling electronic waste is likely to have health implications for both the perpetrators and the communities around the location of smelting because of the use of chemicals in the smelting process which can react with water and air.

Laboratory scale testing; Laboratory-scale testing of precious metal recovery process from electronic waste components is aimed to discover whether there is any stage of the process that is not needed or there is any necessary stage skipped in the process. Laboratory-scale testing was also conducted to determine the ratio of raw materials to the products produced in each phase of the recovery process quantitatively.

Process cost; The Estimated costs of the process of conventionally performed smelting gold from electronic waste components is compared to the estimated costs of melting process in the mining gold. This is done by identifying the components or materials used in each process to determine which process is more economical. Costs incurred in the process of smelting gold from electronic waste component are further calculated through the calculation of cost and benefit.

3 Results and Discussion

A computer processing worker/buster is the person who recycles computer components that still has economic value and deemed appropriate for recycling. The first step to the recycling process is sorting out the components of which were deemed to have economic value; one of these components is IC (Integrated Circuit).

The locations of buster sites are still very difficult to be identified as the place of smelting process is hardly known to the public. Various constraints are often encountered; for instance, some busters whom have successfully been interviewed are reluctant to provide information about the process and sometimes the provided information does not correspond to the facts on the field. Only a few busters that are successfully met and willing to be interviewed by fears and suspicions of the leaking of how the melting process is done. They are also hesitant about what they do because of the awareness that these activities are illegal.

The number of busters successfully interviewed in the survey comes to as many as eight busters. These smelting locations in the city of Bandung consist of three points around the area Astana Anyar, one point located in the surrounding area Cicaheum, three points around the area Ahmad Yani and one point in the surrounding area Banjaran. In general, these agents have a family network so that in the smelting process they are all using the same method.

3.1 Stages of Gold Recovery Process of the Integrated Circuit by Informal Sector

Recovery process is the activity of taking the economic value of the computer-waste component by being dismantled and then further processed to obtain useful metals like gold, copper, and silver in order to become material that has more economic value. The recycling process conducted by informal sector is illustrated in the following diagram:

1) IC separation from PCB

The first preparation is to separate activities of key raw materials required in the process of recovery that was obtained from electronic waste components of IC (integrated circuit). This process is commonly called stripping down process. By the informal sector in the region who do business recovery of precious metal (gold) from waste electronic components, the process of stripping down IC contained in the components of the printed circuit board (PCB) is conducted by the buster by using a simple tool which is ax and conducted without the use of safety equipments such as gloves. This process is performed to obtain the raw materials of pure IC that will be necessary for the next stage. In the first stage of the preparing process Waste A is generated in the form of printed circuit boards.

2) IC combustion

Pure IC which has been obtained is subsequently burned. IC combustion process is performed using the container made of aluminum or zinc. Burning is done by using kerosene fuel or gasoline. The burning process is done approximately in 2-4 hours with a high temperature. The function of burning is to eliminate plastic contained in the IC in order to facilitate the crushing process.

3) IC crushing

IC that has been through the process of combustion is subsequently crushed. The process of crushing is done using Alung/coet and a flat stone. First alung (coet) is used to get the size of IC products to a sandy grain and then filtered using a filter for IC. The residue from the filter is then crushed again, this time using a flat stone to get the IC in the form of powder or fine grains. The function of milling process is to get products crushed . In the milling process waste B is generated in the form of copper.

4) IC Panning

Panning process is the process of getting metal with a large density, such as gold. In order to get products that will be melted, the product is Au, Ag, and other metal impurity. In this washing process the waste generated is waste C in the form of liquid waste and sludge remaining from the panning process. Results from panning is then added borax.

5) Tin Melting

Solid tin is heated by burning using soldering equipment until become liquid and boiled.

6) Slake Removing

In the smelting process the tin that has been boiled in the form of liquid then mixed with the powder/fine grains from the panning process that has been added borax. Heating is done to melt metals in order for the metals to be mixed. Borax is added to eliminate metal impurities of Au and Ag which is commonly referred to as slake. Meanwhile, tin is used to absorb slake. The tin in this process lowers the melting point so it can accelerate the reaction with a perfect dissolution. The tin, being light in weight, can bring borax oxide to the top phase. In the fusion process, two phases will be formed, which is above and below the lowest phase of gold and silver and a bit of metal impurities. Phase formed on top of solid tin slake and subsequently disposed of little by little. This process is conducted approximately 2-4 hours depending on the number of products and accuracy in the process of smelting. In this melting process waste D is generated in the form of solid tin slake.

Reaction:

$$Au + Ag + \text{Metal Impurities} + Na_2B_4O_7 \xrightarrow{\text{heat}} Au + Ag + \textit{slake}$$

7) Gold and silver separation

Once the metals Au + Ag are formed, subsequent purification process is done using HNO_3 solution. The presence of HNO_3 dissolved silver and leaving granules of gold which was then melted again to get the form of solid gold. In this process waste E is generated in the form of acidic effluent waste.

Reaction:

$$Au + Ag + 2HNO_3 \longrightarrow Au + AgNO_3 + NO_2 + H_2O$$

8) Gold metal recovered

In the second smelting process, the result from the purification which is gold grains is then reheated to obtain solid gold with levels around 90%. The main product of the smelting process is a byproduct of gold and copper and silver were produced. The products are usually sold to dealers of metal, gold shops and trash artisans. The price of each metal can be seen in **Table 2.**

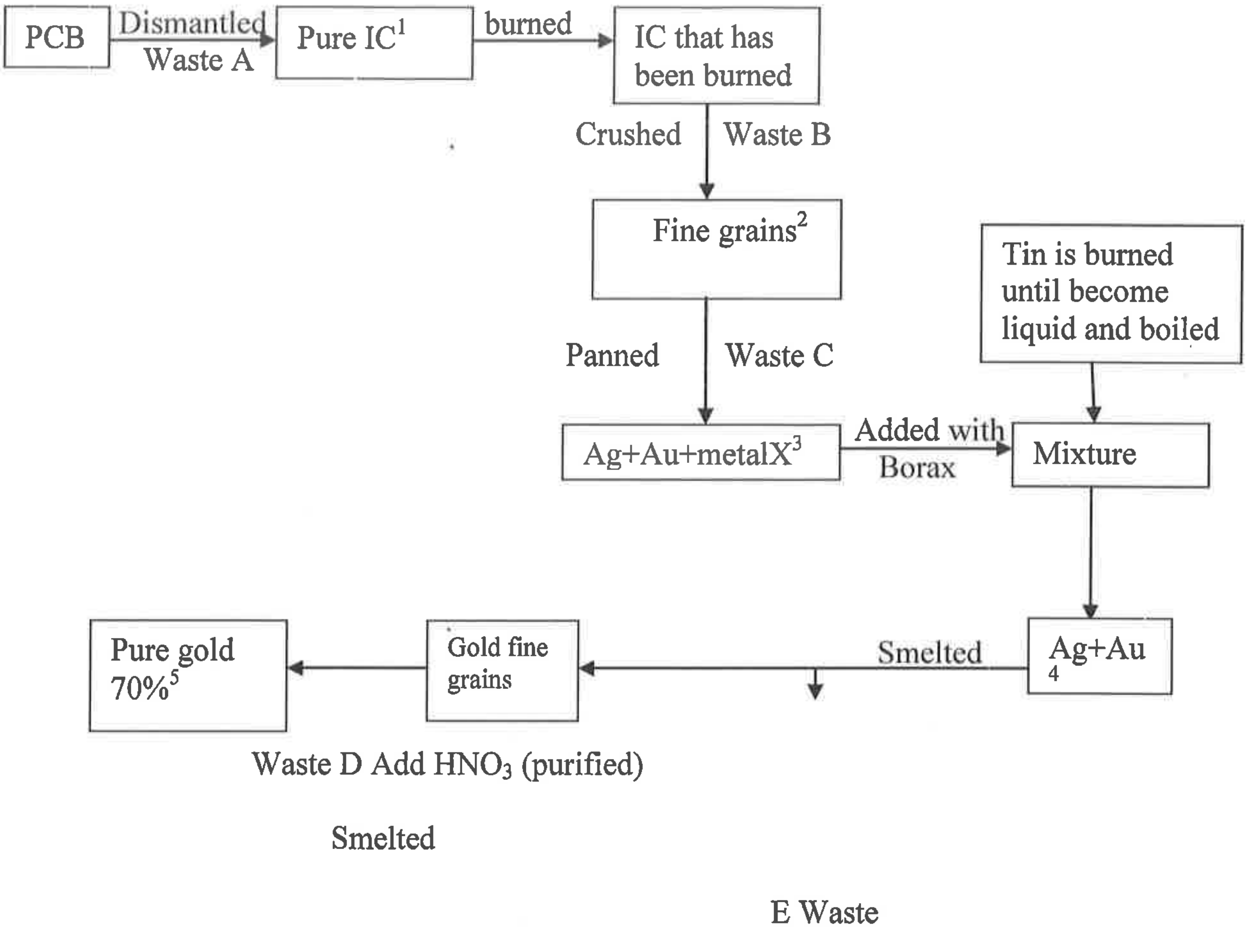

Figure 1 Gold recovery process from *Integrated Circuit* (IC)

Table 1 IC weight in each stage of the recovery process

Stage of Process	Recovered materials (gr)
1	1000
2	650
3	50
4	1,5
5	1

Table 2 Metal Sale Price

Metal	Price (rupiah)
Gold (Au) (per gram)	300,000 – 330,000
Silver (Ag) (per gram)	5,000 – 8,000
Copper (Cu) (per kilogram)	30,000 – 40,000

3.2 Characteristics of Waste Produced from Gold Recovery Process of the Integrated Circuit by Informal sector

In the smelting process carried out by the informal sector produced residues at each stage of the process. In this process five types of waste residues are yielded named wastes A, B, C, D, and E. Wastes are generated in the form of solid waste, wastewater and sediments. Handling of waste generated varies. There are wastes that still has the potential to be further recycled are disposed directly to the nearby drainage channel or river. Comparisons of the field activities is done based on the decision rules KABAPEDAL Number KEP-04/BAPEDAL/09/1995 and Sk.Gub. Jawa Barat No.6 Year 1999.

1) Board Circuit Waste (Waste A)

Waste A generated from the recycling process is in the form of IC circuit board which components have been taken. The waste is dumped near the recycling process and is not sought after for its lack of economic value.

2) Copper Waste (Waste B)

Waste B is in the form of copper pieces remained from the crushing process. Copper waste still has economic value therefore it can still be sold. Usually people who accommodate pieces of copper are scavengers and junkman who then sold them to the dealers of copper smelting.

3) Liquid Crushing Waste and Deposition (Waste C)

Waste C is the residual waste from the panning process. Waste C formed as a liquid waste containing grain remains of IC that is no longer considered useful. Habitually this waste is simply disposed to the drainage or river channel around the site of recycling process. This liquid waste containing sediments also contains heavy metals. The composition of waste C can be seen in **Table 3** and **Table 4.**

Table 3 Heavy metal content in the liquid waste (Waste C)

No.	Parameter	Unit	Analysis Result	Sk.Gub. Jawa Barat.No.6Th.1999	
			Liquid	Group 1	Group 2
1	Arsen (As)	ppm	0.013	0.1	0.5
2	Barium (Ba)	ppm	0.43	2	3
3	Cadmium (Cd)	ppm	0.128	0.05	0.1
4	Chromium (Cr)	ppm	0.001	0.5	1
5	Copper (Cu)	ppm	62.9	2	3
6	Cobalt (Co)	ppm	2.325	0.4	0.6
7	Lead (Pb)	ppm	137	0.1	1
8	Mercury (Hg)	ppm	0.025	0.002	0.005
9	Molybdenum (Mo)	ppm	0.001	-	-
10	Nickel (Ni)	ppm	17.9	0.2	0.5
11	Tin (Sn)	ppm	0.013	2	3
12	Selenium (Se)	ppm	0.009	0.05	0.5
13	Silver (Si)	ppm	0.001	-	-
14	Zinc (Zn)	ppm	32.9	5	10

Table 4 Heavy metal content in the Deposition of IC crushing waste

No.	Parameter	Unit	Analysis Result	Decision of 04/Bapedal/09/1995	
			Deposition	Max. Content Column A	Max. Content Column B
1	Arsen (As)	mg/kg	4.223	300	30
2	Barium (Ba)	mg/kg	0.104	0	0
3	Cadmium (Cd)	mg/kg	0.012	50	5
4	Chromium (Cr)	mg/kg	0.051	2500	250
5	Copper (Cu)	mg/kg	14.555	1000	100
6	Cobalt (Co)	mg/kg	0.184	500	50
7	Lead (Pb)	mg/kg	16.329	3000	300
8	Mercury (Hg)	mg/kg	0.005	20	2
9	Molybdenum (Mo)	mg/kg	0.000	400	40
10	Nickel (Ni)	mg/kg	2.061	1000	100
11	Tin (Sn)	mg/kg	0.004	500	50
12	Selenium (Se)	mg/kg	0.002	100	10
13	Silver (Si)	mg/kg	0.027	0	0

14	Zinc (Zn)	mg/kg	1.940	5000	500

Table 3 shows some of the parameters exceed the stream standards thus they need to be chemically process before discarded. Whereas in the **table 4** wastes in the form of deposits are under grade levels of max A and max B so it can be included in category landfill 3.

4). Solid Tin Slake (Waste D)

There are parties who want to accommodate residues resulting from the smelting process in the form of solid tin slake (tin leftover and metal impurities) as large quantities of this waste can be recycled. For instance, there is still gold in these residues that can be futher recycled.

5). Acid Liquid Waste (Waste E)

Waste E generated from the gold purification process can be further recycled because they still contain silver in the waste. The process to get the silver is being done with the addition of salt as the settling process which then smelted to produce the form of silver metal.

Reaction: $Ag(NO_3) + NaCl \longrightarrow AgCl_{(s)} + NaNO_3$

In product AgCl of the reaction is then smelted

$$AgCl_{(s)} \xrightarrow{heat} 2Ag + Cl_2$$

Meanwhile, the metal content in the wastewater that is discharged thoroughly to the drainage can be seen **Table 5**.

Table 5 Metal content of purification waste (waste E)

No.	Parameter	Unit	Analysis Result	Sk.Gub. Jawa Barat.No.6Th.1999	
				Group 1	Group 2
1	Arsen (As)	ppm	0.024	0.1	0.5
2	Barium (Ba)	ppm	0.25	2	3
3	Cadmium (Cd)	ppm	0.198	0.05	0.1
4	Chromium (Cr)	ppm	0.694	0.5	1

5	Copper (Cu)	ppm	65.8	2	3
6	Cobalt (Co)	ppm	0.196	0.4	0.6
7	Lead (Pb)	ppm	32	0.1	1
8	Mercury (Hg)	ppm	0.023	0.002	0.005
9	Molybdenum (Mo)	ppm	0.001	-	-
10	Nickel (Ni)	ppm	2.439	0.2	0.5
11	Tin (Sn)	ppm	0.011	2	3
12	Selenium (Se)	ppm	0.003	0.05	0.5
13	Silver (Si)	ppm	1.058	-	-
14	Zinc (Zn)	ppm	2.97	5	10

In **Table 5**, it can be seen that some of the parameters exceed the stream standards thus they need to be chemically processed before disposal.

3.3 Cost and Benefit

Table 6 Cost of gold Recycling From E-waste

Material	Price per unit (Rp)	Need	Total Cost (Rp)
Pure IC	200,000	1 kg	200,000
Koi	2,500	1 piece	2,500
Borax	40	25 gram	1,000
Timah	1,000	5 piece	5,000
HNO_3	12,000	1 liter	12,000
Bensin	4,500	1 liter	4,500
Total Cost			225,000

The products resulting from the recycling process consist of 1 kg IC 1 g Gold, Silver 4 g, 300 g Copper with revenues as follows:

Table 7 Provide of Gold Recycling From E-waste

Material	Weight	Total Cost (Rp)
Gold	1 gram	330,000
Silver	4 gram	20,000
Copper	0.3 kg	10,000
Total		350,000

The buster gains Rp 125,000 for every 1 kg IC recycling. Recycling will provide benefit increases if the process is done in large quantities.

3.4 Scale Testing Laboratory

Experiments carried out by two ways:

1. Same with the existing processes of informal sector
2. Replacing heating furnace had been soldered to 990 ° C

Experiments carried out by using the furnace cannot continue because a process that occurs in a state are closed and no air exchange occurs (oxidation-reduction reactions). Laboratory-scale experiments are done qualitatively and quantitatively and compared with the results of the recycling survey conducted by the informal sector. This comparison results can be seen in **Table 8**.

Table 8 IC weight in each stage of the laboratory-scale recovery

Stage of Process	Recovered Materials (gr)
1	500
2	350
3	30
4	0,7
5	0,4

% *recovery* = (0,4 mg / 500 mg) * 100% = 0,08%

4 CONCLUSION

The process of e-waste recycling by the informal sector has the potential to be developed, because the gold content and the recovery percentages are good. There are some of the waste from the recycling process which are potential to be further recycled, such as solid tin slake waste and acid liquid waste. Recycling activities conducted by the informal sector is economically feasible but not environmentally soundly. It can be seen from the results of laboratory-scale testing that the quality and quantity of product produced is almost the same as that done by the informal sector.

5 REFERENCES

[1] Widyasana, I. M. W., Sukandar and Damanhuri, E., *The Role of Informal Sektor in E-waste Handling in Bandung City, International Conference of Sustainable Environmental Technology and Sanitation for Tropical Region*, ITS Surabaya.2008.

[2] Damanhuri, E. and Sukandar, *Preliminary Indentification of E-waste flow in Indonesia and its hazard characteristics,* the third NIES workshop on e-waste, japan.2006.

[3] Damanhuri, E. and Sukandar, *E-waste disposal & health and safety in 5R of E-waste, Regional training and workshop for environmentally sound management of e-waste,* Siem Reap, Cambodia.2007.

[4] Shirahase, T.,Kida, Akiko,*Case Study Of Metal Content In E-waste, Analysis Of 100 Parts In A Personal Computer,* Proceedings of The Third NIES Workshop on E-waste.Japan.2006.

[5] UNEP. *Preliminary Inventory Of Electronic and Electrical (e-waste) in Indonesia.* Basel Convention. Jakarta. 2007.

[6] Yang, J. *E-waste flow and recycling situation in china, Research Center for Eco-Environmental Sciences. China.* Proceedings of The Second NIES Workshop on E-waste, Tokyo Japan, 2005.