

Waste Engineering and Management

Proceeding

SIBE-2009

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

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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
Volume H : Environmental Protection and Management

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
- **Prof. Ikuo Towhata**
  School of Engineering, University of Tokyo, Japan
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  Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **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 174 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

International Conference on Sustainable Infrastructure and Built Environment in Developing Countries
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Identification of Clean Production Opportunities at Textile Industry of "PT X" in Indonesia

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Abstract
Clean production is a preventive and integrated environmental management strategy. The implementation of this production technique should be prioritized by industry to minimize pollution type and volume, which needs to be continuously applied to production process and production life cycle. The application of clean production to industry needs feasibility analysis by conducting a technical study and an economic study of identifiable clean production opportunities. PT X, a synthetic fiber spinning textile industry in Indonesia, is making efforts to apply clean production which has capability to reduce ensuing waste. This study intended to analyze economic and technical aspects of clean production of PT X Indonesia using material balance method. PT X Indonesia produces ± 3%-8% waste from total production monthly. Standard for maximum waste in fiber spinning textile industry is 4%. From the point of the aggregate existing process unit, PT X Indonesia's production system performance is not sufficient enough judging by the large amount of waste produced. This study resulted 18 clean production opportunities. The applicable clean production opportunities are, among others, modification and replenishment of new equipment, sound administration, job description of raw material and improvement of existing job description at process unit, machinery and equipment maintenance documentation and machinery examination, store room incoming raw material management by inventory management, and training provision. By implementing these opportunities, PT X Indonesia is expected to obtain an identifiable total saving of Rp 154.765.324 /month by providing training, arranging or improving job description (SOP) as first priority that could yield the largest amount of saving, as much as Rp. 110.400.000/month and obtaining benefit from environmental quality management and implementation of continuous perfection of production process.

Keywords : clean production, material balance, saving, SOP, textile.

1. Introduction

In order to cope with pollution impact and to undergo sustainable and environmental-friendly development, Indonesian Government have specified various policies. One of the policies is by applying Clean Production for industrial activity. This clean production is new approach to handle the problems of industrial environment which has more characters of the prevention, reduction and or elimination of waste directly from the source and at the same time yields product with standardized quality and quantity (Wibowo,1998).

During production process, an industry requires resource utilization efficiency (energy, material/raw material) and high productivity. In order to reach those objectives, the industry must pay attention to waste minimization at the source rather than waste treatment both in quantity or quality of the waste, and as the result it will reduce production cost.

PT X Indonesia which is located at JL A.H Nasution KM 9 Sindanglaya Bandung , is a synthetic thread spinning textile industry such as polyester and acrylic, This industry is trying

to apply clean production to reduce waste. PT X Indonesia generated solid waste about 3% - 8% from total produced. Spinning product capacities is equal to 600 ton per month, with amount of spinning needle of 51.360. PT X Indonesia employs 805 workers, in which 128 men and 677 women.

In its production process, the generated waste are mostly in the form of solid waste and dust, and these could be categorized as recyclable and reusable waste. This generation of the waster, basically, resulted from the differences between raw material consumption and the products amounts in which the production process strongly influenced by air moisture, human errors, damage of machine, inaccurate mixture formula, and poor quality of raw material. Application of clean production is expected to increase productivity and to minimize the solid waste until zero effluent therefore it can reduce production cost, usage of energy and raw material consumption.

The objective of this research is to evaluate the production process of spinning of thread being run towards clean production in PT X Indonesia with the approach of waste minimization directly from the source that this concept can be proposed to the industry as clean production implementation. This research of clean production opportunity was focused only on solid waste generation, but not on liquid waste and gas that will be studied furthermore.

2. Materials And Methods

Feasibility analysis of clean production opportunity was done by economical and technical analysis. Calculation method which applied in this research was done to evaluate production opportunity economically by applying payback period method i.e. time which required so that benefit will be equal to amount of investment/cost and rates method. Technical analysis of clean production opportunity was done based on production process path, mass balance and waste and source of waste identification, as well as mass balance analysis.

In order to analyze the results, the primary and secondary data was required which obtained from observation, interview and discussion with stakeholder in the company, which are operators, employees, engineering team and other party related to this research. Primary data included production process detail, measurement of waste, conformity of job method with condition of field. In other hand, secondary data included company documentation, usage of raw material and benefactor material and others data. The related textbook, internet, and other media were also used to strengthen the analysis of the data.

3. Results and Discussion

a. Analysis of mass equilibrium

Analysis of mass equilibrium is an accurate calculation of output and input operation in an operation unit, and in the overall production process. In order to analyze mass equilibrium, the inventory of input data, input data of a process or operation which covers main product, by product, and waste (solid, liquid or gas) was required.

After mass quilibrium analysis has been performed, it could be identified that waste primary source, deviation of processes related to waste generation , the cause of losing of raw material, and operation unit generating waste, has exceeded the standards. Scheme of production mass equilibrium on September 2006 is illustrated in **Figure 1.**

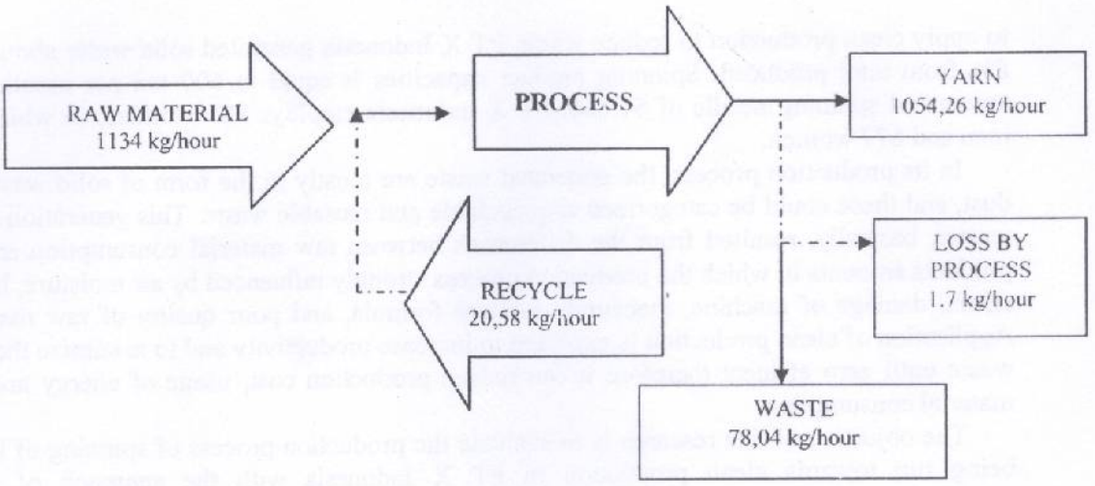

Figure 1 Production Mass Equilibrium Scheme in September 2006 (PT X Indonesia)

b. Mass balance analysis

Mass balance analysis is performed to identify clean production opportunity which is possibly implemented in industry. Table 1 shows mass balance of spinning of yarn in September 2006

At spinning of yarn industry, mass balance analysis is grouped based on production processes phases in 1 workday covers : total lost time, total raw material input, amount of waste generated, and raw material difference to amount of products. From mass balances that shown in **Tables 1** it could be identified that leaks and spills at blowing processes units and other units still generated particulate, fiber and yarn.waste.

Table 1 Fiber Mass Ballance Analyse

No	Raw material Input		Production process		Waste		
	Type of Raw Material	Amount (kg)	production unit	Operator (labour)	Type	Amount Recycle	Amount Waste
1	Rayon	4.201	Blowing	4	dropping fiber	1.485,8	9.700
	polyester	205.810			fiber particulate		1.200
	acrylic	404.310			patch in machine		600
	wool	9.394,7					200
2	Lap		Carding	6	Fiber & particulate	400	11.754,8
3	Sliver carding		Drawing	8	Fiber & particulate		6.252
4	Sliver drawing		Roving	9	Fiber & particulate		520,8
5	Sliver roving		Ring spinning	48	Benang reject, benang kusut &partikulat Rejected Yarn, tousled yarn & particulate	9.460	6.251,6
6	Yarn		Winding	28	Tousled yarn & particulate		500
7	Yarn		Packing	3			224
	Total	625.125,2	Total production	575.627,4	TOTAL	11.345,8	37.203,2
Raw material difference to amount of productions		49.497,8Kg/month	Production cost = 5.000 Rp/Kg		Cleaning of machine 3 time a week @ 1 hour/day Total losing of time was 3 hour/day		
Difference to amount of productions = 8,59%					Loss by process = 2,13%		

Analysis based on PT X Indonesia data, 2006

c. Analysis of clean production opportunities implementation

Clean production identification is meant to increase the efficiency at production unit or waste minimization at the source. Identification was done by evaluating inefficiency source at operation or process and also giving alternative trouble-shooting by referring to the previous best practices technology which has proven both qualitatively and quantitatively. Clean production opportunity is analyzed based on description of the process and waste identification, then subsequently grouped according to the production process unit in PT X Indonesia. Clean production opportunities are shown in **Table 2**.

Table 2 Identify Clean Production Opportunity

No	ProcessUnit	Existing Condition	Opportunities Identify
1	Raw material	**Ordering Unit** Both marketing and ordering process were done by marketing unit	• Compilation of SOP • Job steps would be more arranged and planned causing efficiency and productivity increase and working time efficiency
		Acceptance Unit • Recording was only done based on order number in warehouse. • Inspection of raw material is not done everytime • Raw material is not accompanied by MSDS data	• Application of inventory management through JIT method • Inspection of raw material should be done every arrival of goods • Documentation • MSDS attachment for all raw material type that applied • Application of SOP and good house keeping should be started from acceptance and storage
		Storage Unit • Moving process with forklift can destroy the packages • Dark warehouse, moist and poor air circulation • Fiber and yarn warehouse is far from production room • Raw material and products has exceeded storage capacities	• Spacing between lot in warehouse should be adjusted to facilitate ease in transportation of forklift therefore damage at raw material will not be occurred • Addition of ventilation at fiber and yarn warehouse • At the time of transportation of fiber and yarn, plastic cover should be applied. • Application of inventory management • If possible, the warehouse should be removed close to production room
2	Blowing	• Spills and leaks of fiber at the time of feeding was dropping fiber and flown fiber which disturb respiratory system • Spills and leaks of wax at the time of liquid wax transportation from drum into a bottle of 19 liter • Machine maintenance was unconfirmed with job description • No maintenance record data	• Application of SOP properly, good house keeping, job description improvement • Documentation for every process unit will facilitate checking activity • Devices modification
3	Carding, Drawing, Roving, Ring, Spinning, and Winding	• Waste of yarn and fiber was generated abundantly • Cleaning of machine was conducted once per day at the time of replacement shift	• Application of good house keeping and SOP Machine maintenance should be better done according to SOP • Documentation of operation and

No	ProcessUnit	Existing Condition	Opportunities Identify
		• Operator often do mistake when joining yarn to the next machine	maintenance of each machine should be arranged well for facilitating checking activities
4	Packing	• Operator s were sometimes careless in separating the cone and placing the cone on the proper lot • No pallet for yarn that will be packed was available • Poor understanding to the job instruction	• Application of good house keeping and SOP • Provide pallet for yarn that will be packed • Training for operators
5	Human Resource	Upgrading of awareness at middle up managerial level	Training to increase better human recourse capability

Analysis based on PT "X" Indonesia data, 2006

d. Economic and technical analysis

Clean production opportunity evaluation is performed based on feasibility analysis technically in order to know the impact of opportunities which have been identified toward process, quality of product, security etc. Technical analysis was performed to determine whether the alternatives of clean production which proposed will affect directly to the production process, product quality, job quality etc. or not.

Economical evaluation is a key parameter for making decision to select clean production opportunity, This evaluation includes comparison of operational cost to figure out where the cost minimization can be done, comparison of the present waste treatment cost with the costs attributed to clean technologies alternatives, annual operational cost calculation for all processes including waste treatment and forecasting cost to the changes referring to clean technologies, consideration of investment cost which needed to apply every alternative of clean technology, consideration of environmental advantage and process as well as waste treatment cost. Method used in this economics analysis was payback period method i.e. time required to achieve total benefit that will be equal to amount of investment cost.

Clean production opportunities were analyzed economically by converting advantage obtained by the company into rupiah nominal value by comparing investment value with predicted advantage that will be obtained.

Investment that was required for improving job description and conducting training was equal to Rp.9.374.000 with the thrift of Rp.110.400.000/month. The investment cost for addition of ventilation was Rp 8.278.000 with the thrift of Rp.6.900.000/month. The investment cost for modification creeper lattice was Rp.8.598.400 that will save money as much as Rp.37.260.000/month. The expense of documentation for machine operational and treatment would be Rp230.000, hence we will obtain cost saving from replacement of devices that equal to Rp.9.699/month. Meanwhile, the investment for addition of pump at liquid wax depositor drum is equal to Rp40.500 that will minimize cost for purchasing of wax as much as Rp 95.625/month, and lastly the cost minimization by utilizing ex- packaging of raw material as pallet at the packing unit would be equal to Rp.100.000/month.

4. Conclusion

A study of PT X Indonesia showed 18 clean production opportunities. The applicable clean production opportunities are, among others, modification and replenishment of new equipment, sound administration, job description of raw material and improvement of existing job description at the process unit, machinery and equipment maintenance documentation and machinery examination, store room incoming raw material management with inventory management, and providing training. By implementation of these opportunities, PT X Indonesia is expected to obtain an identifiable total saving of Rp 154.765.324 /month with giving training, arranging or improvement job description (SOP) as first priority that could yield the largest amount of saving, i.e., Rp. 110.400.000/month and obtaining benefit from the view of environmental quality management and capability of continuous improvement of production process implementation.

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