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Cleaner Technology Application in Printing Factory (Offset Lithography System)

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Abstract

Not only the ancient industry, but printing industry is also an important one of Thailand. From sampling factories review [1]-[5], there are three aspects of environment problem of productive process that are detailed as follow: air pollution, wastewater, and energy losses. This research has the purpose to identify the use of resources and pollution point of sources including the causes in processing of offset packaging printing factory in order to apply the principles of clean technology for air pollution reduction, standardization of waste water and electrical power reduction in a packaging and printing factory. The case study employed was a packaging and printing factory with a capacity of 2,241.2 Ton/Year. The proposal for cleaner technology is to apply an air-conditioning system with an Evaporative Cooling System that reduces power consumption of 149,841.79 kWh/year or 39.66% with saved costs equivalent to 14,210.49 USD/year. The energy saving air-conditioning system also reduces intensive inhalants in the air concentration of the production area (printing area) to reach the standard criteria. Waste water separation for appropriate water management helps save a total of 119.69 USD/year and reduces waste water by 0.56 m³/year or 0.8%. Construction of a waste water treatment system in the first year enhances the lawful processing which can save 6580 USD/year and reduce waste water by 4.83 m³/year or 6.96%, and provides water recycling of 45.201 m³/year. A year after cost expenditure for the system is 1246.17 USD/year, with, when compared to delivering waste water for eradication, can save 241,215.03 Bath/year.

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1. Scope of study

The research focuses on the assessment implemented by clean technology (CT) to inquire into the cause of air pollution, wastewater and electrical power loss. The main application of clean technology is to minimize air pollution in the production area (printing area), to develop wastewater treatment of processing starting from input to output and reduction of electrical power in the production area. Printing Innovation Co., Ltd. was the study site, which is an offset packaging printing factory.

2. Methodology

2.1. Primary assessment

- 1) To collect data concerned with resource consumption such as factory map, raw material consumption data (paper, plastic).
- 2) To prepare a schematic for the production line and production diagram by collecting data from documents and a walk through survey of the production line.
- 3) To identify substances/energy for input and output of each process by listing input/output mass and energy of each process.
- 4) To choose areas or issues for assessment, subject to the environment priority with following formula.

2.2. Assessment

Upon learning about high area and high loss issues, the assessment is taken for mass balance of input/output energy.

- Assessment on Air Pollution
- Assessment of Electrical Power
- Assessment on Waste Water

2.3. Feasibility study

2.3.1. Technical feasibility study

Feasibility study is implemented on impact of clean technology proposals to processing, products. The operations are manipulated in laboratory or production line.

2.3.2. Economic feasibility

Data collection for calculating capital investment for proceeding in respect of clean technology proposals to assess the financial worth having the main principles as follows:

- a) Pay Back Period (PBP)

$$PBP = \frac{\text{Whole Capital Fund (USD)}}{\text{Net present Value (USD/Year)}} \quad (1)$$

- b) Net Present Value (NPV)

$$\text{Net Present Value} = \text{Annual Benefit} - \text{Annual Cost} \quad (2)$$

2.4. Environmental feasibility

Each proposal of clean technology is assessed for its benefit on the environment, specifically by an assessment on minimization of air pollution by reducing Benzene, Toluene, Xylene concentrations; assessment on development of waste water quality, which is optimized in compliance with standard criteria; assessment on minimization of electrical power consumption in production areas.

2.5. Selection of clean technology proposal

The selective proposals are taken with consideration of economical savings, air pollution minimization, development of waste water quality in compliance with standard criteria, electrical power consumption maximization for the offset packaging printing factory.

2.6. Implementation

Acquiring clean technology proposals by feasibility study leads to implementation of clean technology together with air pollution measurement, wastewater measurement, power consumption minimization after implementation of clean technology proposals.

3. Results & Conclusions

The pre-assessment process (i.e. primary assessment) found that the printing process consumes maximum resources especially of electricity. Moreover, it released air pollution with a high chemical concentration, which is over the standard criteria, and also created wastewater. Therefore, the area as shown in Fig.1 was selected for assessment.

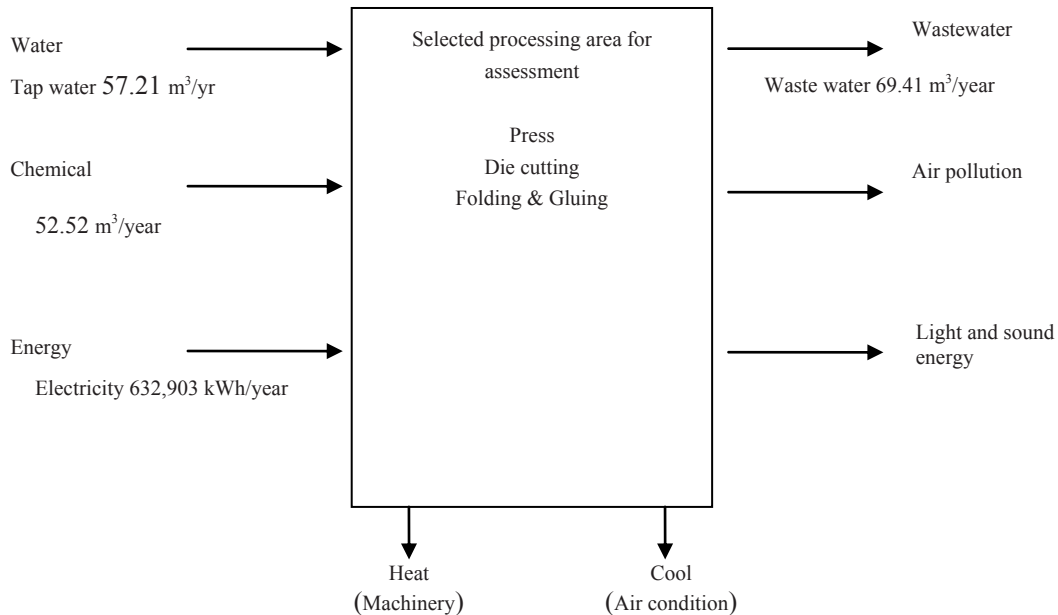


Fig. 1. Substance/energy balance of production area (printing area)

Clean Technology Concept was applied here to reduce resource consumption, waste, and environmental pollution within the printing industry. The steps to accomplish it were composed of printing process assessment, proposed technology proof, and practice that are summarized as follows:

Table 1. Resource use per unit of production

Problem Issues	Main Factor value	Units
1. Water use volume	2.148	m ³ /Ton Product
2. Electricity consumption	479	kWh /Ton Product
3. Chemical substance use	23.43	litter/Ton Product
4. Raw material	1.252	Ton/Ton Product
5. Product loss	0.251	Ton/Ton Product
6. Product	2,241.2	Ton/year

Table 2. Summary of pollution point of sources assessment and cause

Type	Point of Sources	Cause	Method for Prevention and Mitigation
1. Air pollution	Printing Process	- Chemical substances used for the printing process are volatile acid and toxic - Closed circuit air ventilation system	- Use low toxic emission chemicals for printing process - Improvement of air ventilation system.
2. Electricity power loss	Printing process section area of factory	- In appropriate capacity of air conditioner due to over heat load of machine	- Air conditioner improvement for energy saving (Evaporative Cooling System)
3. Waste water	All printing process	- Mixing waste water types of each step of the printing process - No water treatment system for waste water	- Separate waste water for appropriate treatment - Construction of a waste water treatment system

Table 3. Summary of economical feasibility study and pollution reduction by clean technology proposal

Problem Issues	Clean Technology Proposal	Economic Return	Pollution Reduction
1. Air Pollution	Air conditioner energy saving type	- Positive effect on physical and mental states of staff	- Air toxic chemical concentration reduction
2. Electrical power loss	Air conditioner energy saving type	- Saving 14,210.49 USD/year - Investment fund 27,285.57 USD - Pay back period 1.92 years	- Electrical power reduction 149,841.79 kWh/year or 39.66 %
3. Waste water	- Separated waste water for appropriate treatment - Separate Fixer solution - Separate oil from waste water - Construction of waste water treatment system	- Saving 119.69 USD/year - Investment fund 64.51 USD/year - Pay back period 1.86 years - The first year can produce savings of 6,580 USD. - Investment fund 7,181 USD/year - Pay back period 1.09 years	- Reduction waste water 0.56 m ³ /year or 0.8 % - Compliance with LAW - Reduction waste water 4.83 m ³ /year or 6.96 %

- 1) Database of raw materials, water, and chemical substance a result of packaging and printing matters are shown in Table 1.
- 2) The most significant environmental problem issue of the printing factory was caused by chemical use followed by water use and electricity consumption.
- 3) Pollution point of sources assessment for cause analysis and find prevention/mitigation by using CT, which concerns the improvement and modification of tools or accessories are shown in Table 2.
- 4) Clean technology and Financial Return Proposal as well as pollution reduction, which is obtained by use clean technology for demonstration printing factory as shown in Table 3.

4. Suggestion

Based our findings, 3 suggestions are made:

- 1) Based on our review on environmental information of the printing industry [1]-[5], any research is rarely found due to lack of attention to research importance. Most printing factories pay little attention to the environment due to non-readiness of investment funds and insufficient knowledge of appropriate environmental management. Therefore, the government sector should support further research and study as well as appropriate printing factory designs that are friendly to the environment.
- 2) A database of the printing industry resource consumption, such as raw materials, water, chemical substances, and energy should be launched to improve know-how, procedure and equipment that can increase competitive capacity and continuous practicality of clean technology for printing as well as the dissemination of it.
- 3) Academic or research institutes should extend studies and develop clean technology for the knowledge of expansion that complies with the present situation.

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