**The 11th TSAE International Conference**

**26-27 April 2018**

**Available online at www.tsae.asia**

# Application of Cleaner Technology for Energy Reduction in Beverage Carton Packaging,

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**Abstract**

According to the managing of environment and energy are also important in many kinds of industries because they are related to the international standard, governmental requirement and also cost investment. The positive way leading to pollution prevention and cost reduction by applying cleaner technology to minimize the energy consumption. This research has proposed to identify the energy consumption from the cause of process that are top 3 in a beverage carton packaging factory in order to apply the principle of cleaner technology for energy reduction. The case study, the factory has capacity 214.3 million square meter/year and the cleaner technology are applied 1) optimize cooling water from extrusion process, 2) manage the chiller running align the production plan, 3) improve the efficiency of chiller by automatic ball cleaning system, 4) New cooling tower replacement and 5) upgrade gas burner of hot water boiler. The energy reduction result is reduced electrical consumption 1,020,323 kWh/year or 11.1% with saved cost 3,367,067 THB/year. And also reduce the LPG consumption 1,379,988 kWh/year or 63.5% with saved costs as 1,599,737 THB/year. Reducing the energy consumption can reduce GHG in term of $CO_2$ as 601.7 tons/year and 269.3 tons/year in orderly.

Keywords: Cleaner Technology, Energy Saving, Energy Reduction

## 1 Introduction

According the environmental management, pollution treatment and consumed energy are a part of manufacturing cost. The management team focused on disposal priority more than pollution prevention and control, the pollution volume might degenerated the environment. The study was arrived to establish the recycle and efficient management to reduce the industrial pollutants.

Cleaner Technology is a tool for environmental management in term of pollution prevention. It was applied into the assessment process of beverage carton packaging. To reduce the cost and environmental impact from top 3 of energy consumption. This research scope was focused on the potential energy saving project, technical and economical feasibility study and implementation.

The total energy consuming in beverage carton packaging factory was approximately 40,806,740 kWh/year. Electricity was consumed over 90%, the 10% remaining was LPG. The efficient energy use was observed from amount of electricity, green house gases (GHG), other air pollutant emissions as well as cost reduction.

## 2 Materials and Methods

### *2.1 Pre-assessment*

1) To align the energy saving policy and strategy from top management before launching the program.

2) To study the manufacturing process and preparation from the production diagram.

3) To collect the data concerned the energy consumption from each individual process, electricity and production volume of each process

### *2.2 Primary-assessment*

1) Calculate the key factor with the fomula in equation (1) to define the energy efficiency consumption:

$$Key\ Factor = \frac{kWh\ consumed}{Finished\ Goods\ (1x10^6\ m^2)} \quad (1)$$

2) Technical feasibility study is implemented base on the energy loss that identified by the key factor during the whole year for internal bench marking and then compare it by percentage of technical feasibility in equation (2)

$$Technical\ Feasibility(\%) = \frac{100\ x\ (Average\ of Key\ Factor - The\ best\ of\ Key\ Factor)}{The\ Best\ of\ Key\ Factor} \quad (2)$$

3) Economic feasibility study is implemented base on the cost identified by the Economic Possibility Value with the key factor, production volume and cost per unit which presented in formula (3). Then compared it by Economic Feasibility (%) in equation (4).

$$Economic\ Possibility\ Value(\text{EPV},\%) = (Average\ of\ Key\ Factor - The\ Best\ of\ Key\ Fator)\ \ldots\ x\ Unit\ of\ Production\ Volume\ x\ Cost\ per\ Unit \quad (3)$$

$$Economic\ Feasibility(\%) = \frac{100\ x\ EPVi}{\sum_i^n EPV} \quad (4)$$

4) Environmental feasibility study is considered by the energy resources consumed and air pollutions that on quantity, effect and distribution rate and ranking of GHG emission.

5) Ranking and scoring of from each feasibility study. The ranking was provided in Table 1.

Table 1: Feasibility scores

| Possibility Improvement | Score |
|---|---|
| High | 3 |
| Medium | 2 |
| Low | 1 |

*2.3 Detail-assessment*

1) Evaluate the cause of energy loss with area owner who assigned by the management and prioritize the loss that may impact and can be improved.

2) Choose the area or process, mainly focusing on the selected topic from pre-assessment by top 3 score rating.

3) Brainstorm with the team by use the fish bone diagram as in Figure 1 and solve the solutions for fixing the loss, which are CT-options.

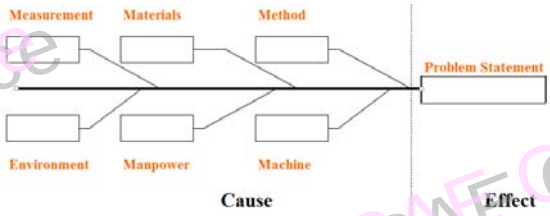


Figure 1 Principle fish bone diagram.

4) Rank and summarize the score to select the topic for improvement

*2.4 Feasibility Study*

1) Selection of cleaner technology options (CT-Options) by consideration of economical saving, energy consumption optimization and air pollution minimization. Each CT-option should be considered and decision involving by top management.

2) Data calculation for proceeding in respect of cleaner technology options to assess the worth having of economical, energy and GHG reduction. The main principles was presented as follows

a) Enery consumption calculation as fomula (5)

$$Electrical\ consumption\ (kWh.Year^{-1}) = Electrical\ Demand(kW)\ x\ \ldots\ Operating\ Hours(hr.day^{-1})\ x\ 350\ days.year^{-1} \quad (5)$$

b) Economial calculation, return of investment as fomula (6)

$$Return\ of\ Investment(ROI) = \frac{Investment\ (THB)}{Annual\ Benefit\ (THB.Year^{-1})} \quad (6)$$

c) Environmental calculation, GHG emission as formular (7),(8)

$$GHG\ emission\ from\ Electricity\ (Ton.year^{-1}) = Electrical\ consumption(MWh.year^{-1})\ x\ \frac{589.7kg.MWh^{-1}}{1000kg.Ton^{-1}} \quad (7)$$

$$GHG\ emission\ from\ LPG\ (Ton.year^{-1}) = LPG\ _{consumption}\ (kg.year^{-1}) x \frac{3.0\ kg.kg^{-1}}{1000\ kg.Ton^{-1}} \quad (8)$$

*2.5 Implementation*

1) Announce the team organization and define the responsibility

2) Execute the project plan

3) Measure and monitor the result of consumption by comparing the efficient of key factor

## 3 Results and Discussion

Due to the pre-assessment process (i.e. primary assessment), it was found that the extrusion process, cooling machines and hot water boilers was the top 3 high energy consumption rate and saving potential score maximum. Figure 2 presented the selected areas for assessment.

Cleaner technology concept was applied to reduce energy consumption and environmental pollution in the beverage carton packaging industry. The stepwise of accomplishment were composed of process assessment, proposed technology proof, and practice that are summarized in Table 2.

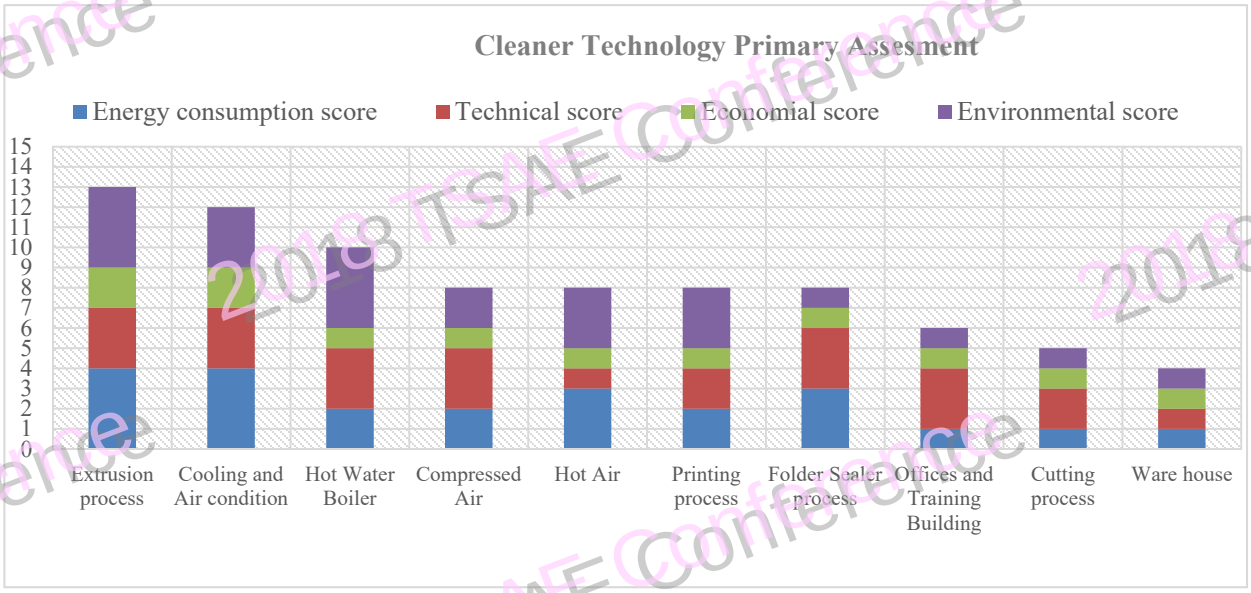


Figure 2 Cleaner Technology Primary Assessment in Beverage Carton Packaging

Table 2 Summary of energy and cause.

| Selected process | Cause of energy loss | Improvement for Cleaner Technology options |
|---|---|---|
| Extrusion | Over supply of chilled water to extrusion process | Optimize chilled water temperature from 12 °C to 14 °C and 16 °C when the machine stoped |
| Cooling and air condition system | The cooling machine running not matching with production plan | Optimize the chiller operation align the production plan |
| | Chiller could not run in full performance according to the chiller tube durty and preventive maintenance schedule limit | Install the automatic ball cleaning inside the chiller tube |
| | Low efficiency cooling tower | Change the new cooling tower |
| Hot water boiler | Burner worn out | Upgrade the burner of hot water bolier |

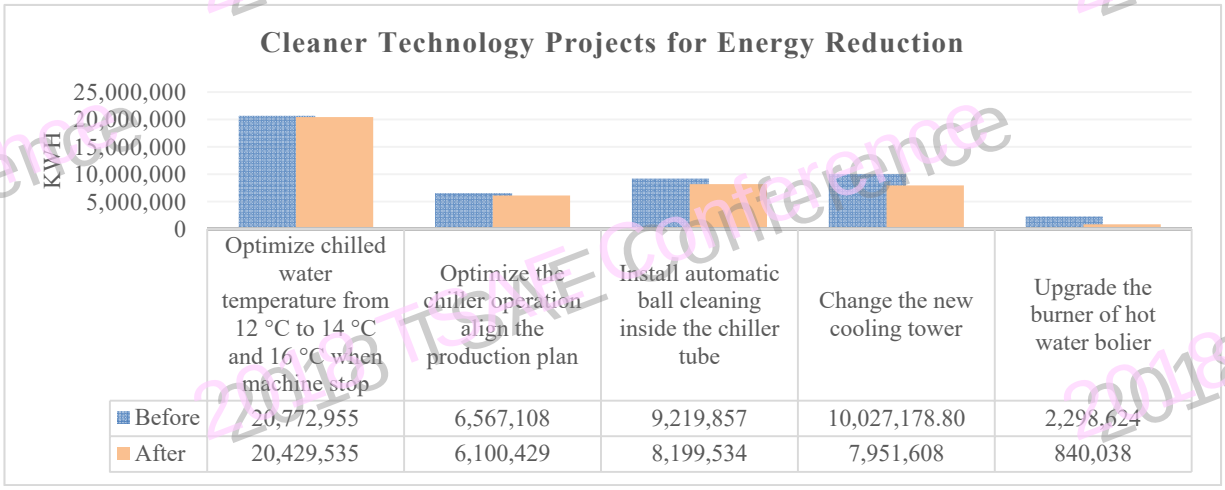


Figure 3 Primary Cleaner Technology Assessments in Beverage Carton Packaging

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

| Cleaner Technology Options | Investment and Return | Pollution Reduction |
|---|---|---|
| Optimize chilled water temperature from 12 °C to 14 °C and 16 °C when the machine stoped | Saving 1,133,286 THB/Year<br>- Investment cost 0 THB<br>- ROI 0 year | - Electrical power 343,420 kWh/Year or 1.7%<br>- GHG 202.5 ton/year |
| Optimize the chiller operation align the production plan | - Saving 981,604 THB/Year<br>- Investment cost 0 THB<br>- ROI 0 year | - Electrical power 297,456 kWh/Year or 7.1%<br>- GHG 73.9 ton/year |
| Install automatic ball cleaning inside the chiller tube | - Saving 3,367,065 THB/Year<br>- Investment cost 1,220,000 THB<br>- ROI 0.36 year | - Electrical power 1,020,323 kWh/Year or 11.1%<br>- GHG 601.7 ton/year |
| Change the new cooling tower | - Saving 8,181,656 THB/Year<br>- Investment cost 10,876,050 THB<br>- ROI 1.33 year | - Electrical power 2,075,571 kWh/Year or 20.7%<br>- GHG 1,340.4 ton/year |
| Upgrade the burner of hot water bolier | - Saving 1,599,737 THB/Year<br>- Investment cost 387,000 THB<br>- ROI 0.24 year | - Heat power as 1,379,988 kWh/Year or 63.5%<br>- GHG 269.3 ton/year |

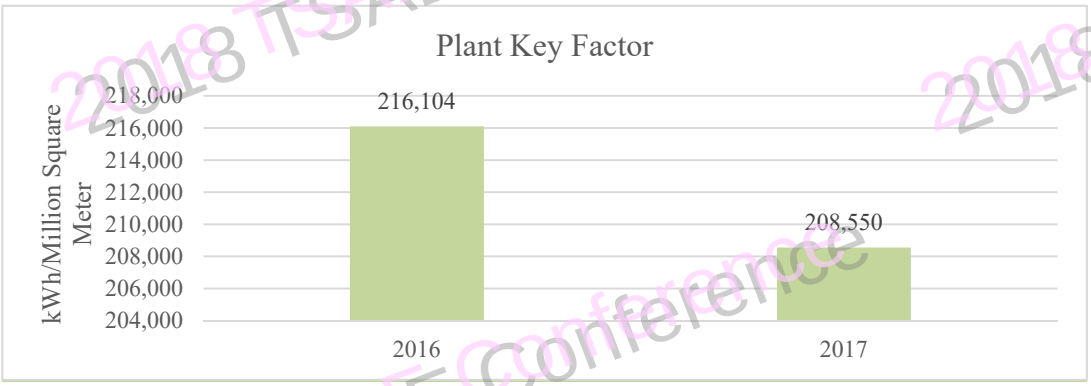


Figure 4 Cleaner Technology Key Factor

## 4 Conclusions

The most significant cleaner technology project and improvement for reduction of energy consumption in term of electrical energy consumption by installation of automation ball cleaning inside of chiller's piping and tube. Decrease LPG in term of heat energy consumption by changing and upgrading the burner of hotwater boiler. The pollution emission in term of $CO_2$ reduction that are show in Figure 3 and Table 3

The energy consumption per unit of output items were obtained by appling the cleaner technology for demonstration on the various area as Figure 3.

## 5 Acknowledgements

Thank you all of Top management, Energy Saving Committee, Plant Maintenance, and Operation team that good support for provide the technical information investigation and all investment.

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