Malaysian Journal of Science (23): 245-249 (2004)

Cleaner production in electroplating industry: A case study

Liew, K. V.[1] and **P. Agamuthu**[2]

[1]Institute of Postgraduate Studies, University of Malaysia, Kuala Lumpur, Malaysia
[2]Insitute of Biological Sciences, University of Malaya, Kuala Lumpur, Malaysia

ABSTRACT Electroplating plants in Malaysia are mostly categorized as small and medium scale industries (SMIs) and there are more than 300 in number mostly situated in the Klang Valley [5]. This case study was conducted at a SMI plant – Metal Polishing Sendirian Berhad situated at Bukit Kemuning, Shah Alam. The plant started operation in 1998 and currently employs 33 staff. This plant was selected as a model plant by Standards and Industrial Research Institute of Malaysia (SIRIM) and Japan International Cooperation Agency (JICA) to devise cleaner production (CP) options. Through implementation of CP the plant is experiencing the benefits whereby operation cost was reduced by approximately RM 3200 per month. There was a decrease in the cost of electricity usage from RM 49,800 to RM 44,800 thus giving a reduction of 10% on the energy bill. A recycling policy was implemented whereby alkaline rinse water was reused and chrome rinsing water were 100% recycled. Chrome rinse or sludge was also reduced from $14m^3$ to $4m^3$. These caused the usage of city water supply to reduce from $979m^3$ to $576m^3$ (a reduction of 41%) with a saving of approximately RM 193 per month. Two personnel were redundant and were removed as the direct result of CP implementation. This gave a saving of RM 1200 per month. The CP usage resulted in increased efficiency, cost saving and the plant was able to achieve the ISO 14001 in the year 2002.

(Electroplating, cleaner production, Malaysia)

ABSTRAK Kilang-kilang penyaduran elektrik di Malaysia kebanyakannya dikategorikan sebagai perusahaan kecil sehingga sederhana (SMIs) dan terdapat lebih daripada 300 kilang yang beroperasi khasnya di Lembah Klang [5]. Kajian kes ini dikendalikan di satu kilang SMI – Metal Polishing Sendirian Berhad yang berada di Bukit Kemuning, Shah Alam. Kilang tersebut bermula operasi sejak tahun 1998 dan pada ketika ini mempunyai 33 kakitangan. Kilang ini dipilih sebagai kilang contoh oleh SIRIM dan JICA untuk rekaan penghasilan lebih bersih (CP). Melalui perlaksanaan CP kilang tersebut mendapat kebaikan yang banyak di mana kos operasi dikurangkan kira-kira RM 3200 setiap bulan. Penggunaan elektrik juga dikurang di mana kosnya dikurangkan kepada RM 44,800 daripada RM 49,800 dengan itu memberi pengurangan sebanyak 10% dalam bil tenaga. Polisi penggunaan semula dilaksanakan di mana air basuhan beralkali digunakan semula dan air basuhan chrome digunaankan balik secara 100%. Hasil basuhan 'chrome' dan 'sludge' juga dikurang dari $14m^3$ ke $4m^3$. Ini menyebabkan penggunaan air dikurangkan daripada $979m^3$ ke $576m^3$ (pengurangan 41%) dengan penjimatan kira-kira sebanyak RM 193 setiap bulan. Dua kakitangan dipecat sebab perlaksanaan CP. Ini membawa penjimatan sebanyak RM 1200 setiap bulan. Penggunaan CP meningkatkan effisiensi, menjimatkan kos dan kilang tersebut juga dapat penganugerahan ISO 14001 pada tahun 2002.

(Penyaduran elektrik, penghasilan lebih bersih, Malaysia)

INTRODUCTION

Electroplating industry in Malaysia is categorized under small and medium industries (SMIs). It is one of the most polluting industries in Malaysia whereby it contributes to a lot of environmental issues with the release of wastewater and gaseous emission.

The industry is problematic in the sense that it could not comply with environmental and waste disposal regulations in that many of them fails to install treatment systems and for those that have such system, it is often found to have malfunctioning systems or inadequate treatment facilities thereby contaminating the waterways and land with their waste discharges [1]. Issues which are currently face by the industry and

which are most probably likely to continue to face in the future are financial and technical constraints to pollution control and increase tariffs to encourage pollution control [1].

Cleaner production

Cleaner production (CP) is defined by UNEP as – "*the continuous application of an integrated preventive environmental strategy to process, products and services to improve eco-efficiency and reduces risks to humans and the environment*".

Cleaner production was first mentioned at Rio Summit as an important strategy to take forward the concept of sustainable development [6]. Agenda 21 made significant references to Cleaner Production and has in fact served as a guiding framework for the implementation of Cleaner Production whereby it also provided a direction and focus to the adoption of Cleaner Production on a multi-stakeholder and multi-partnership basis [6]. Powerful combination of economic savings and environmental improvements which cleaner production brings made it to be recognized in Agenda 21 as a means of reconciling environmental protection and development [7].

The government of Malaysia has done much with various collaborating bodies on the issue of pollution prevention that eventually come to the adoption of cleaner production in some of the most polluted industries in Malaysia. Bodies such as JICA, SIRIM, DANCED (Danish Cooperation for Environmental & Development, DOE (Department of Environment, Malaysia) come up with plans and proposals on various issues pertaining to the adoption of cleaner production in Malaysia. For example, the collaboration of JICA and SIRIM on the cleaner production model for electroplating industry which is the main focus of this case study. Whereas with DANCED, SIRIM also collaborated in the demonstration projects from three industrial sectors which namely electroplating, food, textile dyeing and finishing industry [3].

The Ministry of Science, Technology and the Environment, Malaysia also mentioned cleaner production in the National Policy on the Environment whereby industries will be encouraged towards self-regulation and self-help in pollution prevention and control, especially amongst the larger firms, which are capable of adopting clean technologies and have the financial resources to do so [2].

GENERAL OVERVIEW – METAL POLISHING SDN. BHD.

A case study was done on Metal Polishing Sdn. Bhd. Situated in Bukit Kemuning of Shah Alam with its main product as tri-nickel chrome plating. The company was established in the year of 1998 and was relocated to the current location in the year of 1999. The company currently is employing 33 people with operation of approximately 10 hours per day. It was one of the model plant selected under the JICA-SIRIM cleaner production project in 2001 and has been practicing cleaner production as its production policy [4]. In the year of 2002, it was awarded the prestigious ISO 14001 which stands for compliances with environmental laws and production policies imposed by the proprietor of the company.

Through the implementation of cleaner production, there was a mark improvement in terms of monetary gains and quality improvements. Better management system were implemented and newer technologies were being imposed as to substitute the older technologies used in before cleaner production.

PRODUCTION, ENERGY CONSUMPTION AND TOTAL SAVINGS

Before the implementation of cleaner production, total output was 1 million ringgit. But after the implementation of cleaner production, total output was reduced to 900,000 ringgit. Energy consumption was reduced from 197 kWh to 171 kWh after cleaner production (Table 1). In total, electricity bills were reduced from RM 49,794.00 to RM 44,118.00 (Table 2).

Electrical equipment

A list of the main electrical equipment, their ratings, and hours of utilization during the day is given in Table 3.

BY-PRODUCTS/WASTE PRODUCTS

Alkaline rinse water produced was reused and chrome rinsing water was 100% recycled. There is no other utilization for the above waste produced.

Table 1. Efficiency of cleaner production implementation and savings achieved.

Items	Before cleaner production (July to Oct 2002)	After cleaner production (Nov to Feb 2003)	Savings
City water	979 m^3	576 m^3	403 m^3
Chrome rinse/ sludge	14 m^3	4 m^3	10 m^3
Electricity	197,000 kWh	171,000 kWh	26,000 kWh
Manpower	0	2 (shed)	2 workers shed

Table 2. Total savings in monetary term (RM) after 4 months of cleaner production implementation (Nov to Feb 2003).

Items	Amount	Savings in terms of RM
City water	403 m3 x 1.92 RM/m3	RM 773.76
Chrome rinse / sludge	10 m3 of chrome rinse + sludge	RM 534.47
Electricity	26,000 kWh x 0.258 RM/kWh	RM 6708.00
Manpower	2 workers x RM600/worker x 4 months	RM 4800.00
Total		RM 12816.23

Table 3. Main electrical equipment, their ratings, and hours of utilization.

Equipment	Usage	Duration
Heaters	6000 watts x 40 NOS	16 hours
Rectifiers	20000 watts x 7 NOS	10 hours
Motors	2750 watts x 10 NOS	15 hours
Blowers	3750 watts x 1 NOS	10 hours
Compressor	2250 watts x 1 NOS	3 to 4 hours

ENERGY MANAGEMENT

Person responsible for energy management is Mr. Senthil Kumar which holds the position of QC Engineer with a qualification of electrical engineering. There is a 'progress report' on the energy management of the plant and there are energy program objectives to be achieved. Apart from that, there is also analysis done on energy use and there is also a formal energy efficiency target program implemented.

Energy conservation problems and activities

Major energy problems as viewed by the plant management is the heating up and heat lost of plating bath during the operation hours and it indicated that there are potentials for energy conservation in plating bath. The plant was able to implement their energy conservation recommendations on the boilers in the plant. There was no decision making criteria for capital expenditures for energy efficiency projects and no feasibility studies been conducted for major capital investments.

ENVIRONMENTAL MANAGEMENT

The following systems for environmental management have been implemented or planned in the next 3 years ahead.

a. Impacts assessment for new plant
b. Environmental audits for sites
c. Audit for production processes
d. Annual environmental reports
e. Environmental reviews of suppliers

EMPLOYMENT AND SKILLS IN RELATION TO CLEANER TECHNOLOGIES

A combination of in-house and external suppliers has been used for the design and development of cleaner production technology solutions. Trainings have been carried out in relation to adoption of cleaner technologies which includes environmental awareness courses for management, environmental awareness courses for engineers, and environmental awareness

courses for shop floor staff. Trainings were also carried out for environmental management systems which relates to the awards of ISO 14001.

As a direct result of investment in cleaner technologies, jobs have been shed mainly on the semi-skilled workers. This is a direct result of the investment of cleaner technologies as cleaner production and better products are obtained so less manpower are needed for handling and checking.

Over the next 3 years, it is expected that investment in cleaner production would give more employment in the field of management, process engineering, skilled production, and semi-skilled production. It is also expected that more in-house expertise in cleaner process technology, environmental management, and environmental product design would be needed which includes as well the use of more environmental consultants.

INVESTMENT IN CLEANER PRODUCTION

Various improvements were made in energy management systems to reduce energy consumption and improve efficiency. Plating baths were lined with double lining and insulator to prevent heat lost, periodical maintenance on contact points or jigs, and periodical removal of impurities in the chrome plating bath were also implemented.

Apart from that, the plant has also invested in new process technologies for waste minimization, recycling and substitution for polluting substance. These include JICA sponsored ion exchanger, recycling of alkaline rinsing water to maximize the usage and the recycle of gloves. There was also a substitution of higher temperature chemicals to lower temperature chemicals.

No new products were introduced that minimize energy consumption and waste and to maximize scope for recycling but the feasibility will be investigated by the plant in the future. Same things also happen to the redesign of existing products in order to minimize energy consumption and waste, and to maximize scope for recycling whereby the feasibility will also be studied in the future.

End of pipe technologies for pollution control were fitted for existing processes that generate wastes whereby it constitutes about 60 to 70 % of relevant production processes. Roughly about 30 to 40 % of the waste generating production processes have been redesigned as, or replaced by, cleaner technologies. In the future 3 to 4 years of time, it was foreseen that 50 to 60 % of the relevant processes is expected to be controlled by cleaner technologies. Currently 10 to 20 % of products have been redesigned or replaced to make them environmentally cleaner and it is foreseen that the plant will keep the proportion for the coming 3 years ahead.

Steps have been taken by the plant to acquire specialist expertise in relation to cleaner technologies which includes the use of specialist consultants and the training of existing staff in environmental technology and management. It was also found that the plant did not face any difficulties in acquiring knowledge and skills in pursuit of cleaner technology initiatives.

CONCLUSION

Through the implementation of cleaner production, it is observed that Metal Polishing Sdn. Bhd. has gained much with the improvement of standard of products as well as comply with the environmental management systems recommended. Through the awards of ISO 14001, it further proves that Metal Polishing Sdn. Bhd. is indeed a plant which is actively pursuing the implementation of cleaner production and strives to be a model plant among its competitors.

REFERENCES

1. Department of Environment (2001), *Industrial Processes & The Environment (Handbook No.1), Metal Finishing-Electroplating.* Ministry of Science, Technology and The Environment, Malaysia.
2. Department of Environment (2002), *National Policy on the Environment.* Ministry of Science, Technology and The Environment, Malaysia .
3. Hamdan, M., B.G., Yeoh, M. F., Adnan (1999), Toward Cleaner Technology in the Electroplating. Chapther 11. Cleaner Production Practice in General Industry. *Proceedings of the 2nd Asia Pacific CP Roundtable.*

4. JICA-SIRIM (2002), *The Study on Promotion of Cleaner Production in Industrial Sector, Draft Final Report, Volume 1.* Mitsubishi Chemical Engineering Corporation. pp 8-1 to 8-28.
5. Lu, S. H. (1999), Pollution Prevention Made Profitable – Some Case Studies. Chapter 2. International CP Experiences. *Proceedings of the 2nd Asia Pacific CP Roundtable*, pp 135 -139.
6. United Nations Environment Programme (2002), *Sustainable Consumption and Cleaner Production Global Status 2002.* Division of Technology, Industries and Economics, United Nations.
7. United Nations Environment Programme (1995), *Cleaner Production Worldwide*, Paris: United Nations Environment Programme, 1994.