PART 2

PILOT PROJECT

FOR PROMOTION OF CLEANER PRODUCTION (CP)

CHAPTER 7

IMPLEMENTATION SCHEDULE OF CP

DEMONSTRATION PROJECTS

CHAPTER 7 IMPLEMENTATION SCHEDULE OF CP DEMONSTRATION PROJECTS

An overall construction schedule for CP equipment introduction was prepared as shown in Table 7-1 and was based on the overall schedule of the demonstration project and delivery period of the main equipment.

7.1 Preparation of Tendering Document

Tendering documents were prepared taking into account the procurement conditions of CP equipment in Malaysia. The tendering documents consisted of the following items and were tendered to bidders at the end of March 2001 for Metal Polishing Industries Sdn. Bhd., Winner Food Industries Sdn. Bhd. and South Asia Textiles (M) Sdn. Bhd. and at the end of June 2001 for Perusahaan TGB Sdn. Bhd. based on each CP equipment introduction plan.

(1) Service Agreement among SIRIM, the Study Team, the Supplier and the Model Factory,
(2) Request for quotation,
(3) Requisition,
(4) Purchase Order General Terms and Conditions, and
(5) Form of Secrecy Declaration.

(1) Service Agreement among SIRIM, the Study Team, the Supplier and the Model Factory

This memorandum is an agreement about the right or claim on possession, operation and maintenance of CP equipment among SIRIM, the Study Team, the supplier and the model factory.

(2) Request for Quotation

This is an ITB (Invitation to Bidders) and other documents such as "Requisition" and "Purchase Order General Terms and Conditions" were attached. Request for quotation includes the following items.

a. CP equipment items,
b. Completion date of CP equipment introduction,
c. Payment terms,
d. Validity of quotation,

e. Closing date of quotation,
f. Warranties and guarantees,
g. Secrecy for performance,
h. Communications, and
i. Breakdown method of quotation price.

(3) Requisition

This covered all the requirements for CP equipment introduction to be performed by bidders and the following items are included.

a. Reference documents such as basic design data, process flow sheet and layout plan etc.,
b. Scope of work,
c. Schedule, and
d. Supplier's data requirement.

(4) Purchase Order General Terms and Conditions

This stipulated general terms and conditions between purchaser and supplier and the following items were included:

a. Price and payment,
b. Warranty,
c. Passing of property,
d. Test and inspection,
e. Construction schedule and progress report,
f. Substitutions and deviations,
g. Changes and expediting,
h. Non-disclosure,
i. Force Majeure,
j. Indemnity and liability, and
k. Cancellation and termination.

(5) Form of Secrecy Declaration

This is a secrecy declaration by the bidders not to disclose all information furnished by the purchaser to any third party without prior written consent of the purchaser.

Table 7-1 Overall Construction Schedule for CP Equipment Introduction

From March to December 2001

No.	Items	March			April			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.		
1	Preparation of Tedering Document		X																												
2	Making quotation by suppliers			X	X	X	X																								
3	Selection of supplier											X																			
4	Placing purchase order												X																		
5	Detail design																														
	-Process flow sheet												X	X																	
	-Plot plan												X	X																	
	-Equipment													X	X																
	-Construction drawing													X	X	X															
6	Procurement																														
	-Equipment														X	X	X	X	X	X	X	X									
	-Construction materials														X	X	X	X	X	X	X	X									
7	Construction																														
	-Civil & architecture																			X	X	X									
	-Installation of equipment																						X	X	X						
	-Piping																							X	X	X					
	-Electric & instrument																								X	X	X				
	-Painting & insulation																										X	X			
8	Test and inspection																											X	X		
9	Commissioning																													X	X
10	Training																													X	X

7.2 Selection of Supplier

At first, several bidders were selected for each model factory as shown in Table 7-2 and tendering documents were given to them.

Table 7-2 Bidders for CP Equipment Introduction

Model Factories	Bidders
1. Metal Finishing and Electroplating Sub-sector	
Metal Polishing Industries Sdn. Bhd.	(1) E.B.S. Patrone (M) Sdn. Bhd.
	(2) Aquakimia Sdn. Bhd.
	(3) Juru Rubcoil Sdn. Bhd.
	(4) Organo (Asia) Sdn. Bhd.
Perusahaan TGB Sdn. Bhd.	(1) Newtron Code Sdn. Bhd.
	(2) Zentrum Sdn. Bhd.
	(3) Vision Machinery Sdn. Bhd.
2. Food and Beverage sub-sector	
Winner Food Industries Sdn. Bhd.	(1) Cimbria Far East (M) Sdn. Bhd.
	(2) Juru Rubcoil Sdn. Bhd.
	(3) Aquakimia Sdn. Bhd.
3. Textile sub-sector	
South Asia Textiles (M) Sdn. Bhd.	(1) Ionics/Enersave Engineering Sdn. Bhd.
	(2) Aquakimia Sdn. Bhd.
	(3) Organo (Asia) Sdn. Bhd.

After receiving quotations from each bidder, SIRIM and the Study Team negotiated with each bidder to confirm the quoted cost and technical items, and finally the following suppliers were selected for each model factory.

<Model Factory>	**<Supplier>**
(1) Metal Polishing Industries Sdn. Bhd.	Aquakimia Sdn. Bhd.
(2) Perusahaan TGB Sdn. Bhd.	Vision Machinery Sdn. Bhd.
(3) Winner Food Industries Sdn. Bhd.	Aquakimia Sdn. Bhd.
(4) South Asia Textiles (M) Sdn. Bhd.	Aquakimia Sdn. Bhd.

7.3 Placing Purchase Order

Purchase orders were placed by the Study Team on the following days for the respective suppliers soon after the negotiations on construction cost and requisition.

(1) Aquakimia Sdn. Bhd. : 22 June 2001
(2) Vision Machinery Sdn. Bhd. : 23 August 2001

7.4 Detail Design by Suppliers

After the purchase orders were placed, each supplier started the detailed design of the following based on the requisitions mentioned above.

a. Basic design data,
b. Process flow sheet,
c. Layout plan (plot plan), and
d. Specifications and drawings for main equipment.

These documents were submitted to SIRIM and the Study Team one by one and they were retuned to suppliers after the approval according to a documents submission and approval procedure.

7.5 Procurement of Equipment and Construction Materials

Some equipment (rice washing machine for Winner Food Industries Sdn. Bhd.) was imported from Japan and in total it took about three (3) months to procure all equipment and construction materials.

7.6 Construction Work

Civil and architecture or structure work was started and completed before the delivery of equipment, and most of the installation work was carried out on a limited day-- such as Saturday or Sunday. There was concern for a while that some installation work would be delayed because of the short schedule; however, all construction work completed almost on schedule.

7.7 Test and Inspection

Tests and inspections on equipment were performed at vendor factories under their own responsibility; therefore, the final tests and inspections were carried out during normal mechanical running operations of equipment and machines at each factory. Several defects were found during test and inspections, but all were corrected by the suppliers.

7.8 Commissioning

Commissioning was carried out for three days continuously at the model factory by the factory. During the commissioning, necessary operating data was collected by SIRIM and the Study Team in order to confirm the performance of introduced CP equipment. Some defects in design and construction work were also found during the commissioning, and they had been modified, repaired or adjusted. The initial and trial operation to be performed during the commissioning was the best opportunity for operators to be trained, and some types of training had been carried out.

CHAPTER 8

DEMONSTRATION PROJECT IN THE METAL FINISHING AND ELECTROPLATING SUB-SECTOR-1

CHAPTER 8 DEMONSTRATION PROJECT IN THE METAL FINISHING AND ELECTROPLATING SUB-SECTOR-1

Model Factory: Metal Polishing Industries Sdn. Bhd.

8.1 Factory Survey Results (General)

8.1.1 Surveyed Factories and their Outline

During the first field survey, the following six representative companies were audited.

(1) Metal Polishing Industries Sdn. Bhd.
(2) Perusahaan TGB Sdn. Bhd.
(3) E-Coat Snd. Bhd.
(4) Aceloy Sdn. Bhd.
(5) Malaysian Electroplating Technology (M) Sdn. Bhd.
(6) Chemobright Industries Sdn. Bhd.

Companies (1), (3), (4) and (5) are doing business in electroplating field, while the business of companies (2) and (6) are anodizing. The outline of each factory is as follows and the present status and CP options for each factory are described in Attachment.

(1) Metal Polishing Industries Sdn. Bhd.

Metal polishing Industries Sdn. Bhd. is involved in the plating business and its major production is three layer nickel and chromium (bright and hard) plating. The factory is located in Bukit Kemuning Electroplating Park that is facilitated with a centralised wastewater treatment plant; thus the factory has no wastewater treatment facility of its own. The main customers are motorcycle assembling factories. The company recognises well the importance of CP introduction, and is implementing to obtain ISO certificates of 9000s and 14000s.

(2) Perusahaan TGB Sdn. Bhd.

Perusahaan TGB Sdn. Bhd. is in the business of anodizing aluminum. It has long tanks of over 6 meters in length, and anodizing the extruded raw materials is the main job. The plant was created about 20 years ago. The present owner took over this plant in 1997. Therefore, there are many areas to be improved on.

(3) E-Coat Sdn. Bhd.

E-Coat Sdn. Bhd. is in the business of plating. The major job of the factory is zinc plating (zincate process) followed by chromating. The factory is located in Bukit Kemuning Electroplating Park that has a central wastewater treatment plant so the factory has no wastewater treatment facility. The company is young and interested in introducing new technologies.

(4) Aceloy Sdn. Bhd.

Aceloy Sdn. Bhd. is in the business of plating. The main process unit consists of zinc plating. It has two zinc plating lines for barrels and for racks. Besides these two lines, there is an isolated zinc-cobalt plating tank. The factory is located in Bukit Kemuning Electroplating Park. There are no wastewater treatment facilities in the factory since a central wastewater treatment plant is installed in the park. The company is interested in introducing high corrosion resistant plating to gain advantage over competitors. Installation of a tin plating facility is planned for the future.

(5) Malaysian Electroplating Technology (M) Sdn. Bhd.

Malaysian Electroplating Technology (M) Sdn. Bhd. is in the business of zinc plating. The factory is under restructuring, and a new wastewater treatment plant is being planned. At this moment the factory is running without wastewater treatment, and the production volume is less than 50% of its capacity.

(6) Chemobright Industries Sdn. Bhd.

Chemobright Industries Sdn. Bhd. is a Malaysian furniture manufacturer. The company started an anodizing business to produce frames and ornaments for its own products. At the factory several kinds of aluminum products (from fist-size to 6 meters extrusions) are anodized. Besides anodizing aluminum, mechanical and chemical pre and post-treatments are applied to the aluminum materials.

8.1.2 Observation of Pollution Control Condition

All electroplating factories are using toxic chromic acid in their treatment. Three of the four electroplating factories are located in an electroplating park that is facilitated with a centralised wastewater treatment plant. Consequently the factories do not have their own wastewater treatment units as described before, and send wastewater to the centralised wastewater treatment plant after separating their wastewater into acidic, alkaline, chromium and cyanide wastewater. One electroplating factory among the four is located in another industrial park which is not facilitated with a centralised wastewater treatment plant, and the factory discharges its wastewater that contains toxic chromium hexavalent without any treatment.

Two anodizing factories are using no toxic chemicals. One of them discharges wastewater after coagulating and filtering suspended solids. Another factory discharges its wastewater after controlling pH value only. Both of the factories are saving rinsing water to the margin that maintains product quality in order to reduce water consumption.

As to exhaust gas, two electroplating factories had installed exhaust ducts and scrubbers. One anodizing factory had installed an exhaust system on an etching tank only, but no scrubber. The other anodizing factory had installed an exhaust system and a scrubber for chemical polishing exhaust gas.

As mentioned above, the reduction of water and fuel consumption is ardently practiced at all factories; however, the atmospheric and working environments are not managed sufficiently.

8.1.3 Waste Disposal, Treatment and Recycling

Sludge precipitated at the bottom of wastewater pits and spent liquid from treating baths are accumulated in all the factories except one anodizing factory. Industrial wastes that mainly consist of sludge and spent liquid are sent and treated at a centralised wastewater treatment plant or consigned to Kualiti Alam Sdn. Bhd.. Industrial wastes are not recycled at all.

8.1.4 Measures for Productivity Improvement

Aiming at high productivity, rinsing time is minimised at all the electroplating factories. Advanced methods to increase productivity are not adopted in the case of treatment using chemicals, such as pretreatment, electroplating, anodizing and post-treatment.

8.1.5 Others

In order to reduce the consumption of thermal energy, processing at a low temperature is practiced as much as possible. Especially in the anodizing process, a low temperature sealing method is adopted. In Japan, low temperature sealing is rarely adopted because of unstable properties. In Malaysia, sealing is seldom applied unless requested by customers. This makes it difficult to maintain superior quality in anodized products. Most of factories are not equipped with big boilers but some of them use small boilers. Heat insulation is provided for treatment tanks which are operated at high temperature, but insufficient heat-insulation is observed at some factories. As for electric energy conservation, advanced technologies are not adopted except for chromium electroplating with high current efficiency.

8.1.6 CP Options in the Metal Finishing and Electroplating Sub-sector-1

Measures for improvement by Cleaner Production (CP) are classified as follows.

(1) Prevention of water and air pollution
   a. Reduction of wastewater discharge
   b. Improvement of wastewater quality
   c. Improvement of working environment

(2) Energy conservation
   a. Reduction of water consumption
   b. Reduction of electricity consumption
   c. Reduction of heat energy consumption

(3) Improvement of productivity
   a. Improvement of product quality
   b. Reduction of chemical consumption
   c. Improvement of production process

Targeted field for CP options are shown in Table 8-1.

Table 8-1 Targeted Field for CP Options

Company / Applicable CP Option	A	B	C	D	E	F
1. Prevention of water and air pollution						
a. Reduction of wastewater discharge	x	x			x	
b. Improvement of wastewater quality			x		x	
c. Improvement of working environment		x	x	x	x	
2. Energy conservation						
a. Reduction of water consumption	x	x				x
b. Reduction of electricity consumption	x	x				
c. Reduction of heat energy consumption						x
3. Improvement of productivity						
a. Improvement of product quality	x		x			
b. Reduction of chemical consumption	x					
c. Improvement of production process		x				

Note-1: A、B、C etc. represent company name as follows.

A: Metal Polishing Industries Sdn. Bhd. B: Perusahaan TGB Sdn. Bhd.

C: E-Coat Sdn. Bhd. D: Aceloy Sdn. Bhd.

E: Malaysian Electroplating Technology (M) Sdn. Bhd.

F: Chemobright Industrie Sdn. Bhd.

Note-2: “x” means applicable CP options.

8.1.7 Selection of Model Factory

Refer to CHAPTER 5, section 5.2 “Selection of Model Factories”.

Metal Polishing Industries Sdn. Bhd. and Perusahaan TGB Sdn. Bhd. were selected as model factories in the metal finishing and electroplating sub-sector.

8.2 Status of the Selected Model Factory before CP Introduction (Metal Polishing Industries Sdn. Bhd.)

(1) Outline of the Factory

Metal Polishing Industries Sdn. Bhd. is located in Bukit Kemuning Electroplating Park in Shah Alam and has 1,200 square meters of building area. There is a wastewater treatment centre in this electroplating park; therefore, the factory does not need its own wastewater treatment facility. This company was established in 1992 and moved to the current location in 1998. There are about fifty employees working now. This factory is operating one production line for three layers of nickel plating, bright chromium and hard chromium plating. The production line has 37 tanks starting from degreasing of raw materials to drying of final products. This production line is operated in 2 or 3 shifts continuously every day, depending on the volume of orders from clients. Their current main products are assembling parts for motorbikes and cars. Metal Polishing Industries Sdn. Bhd. is going to obtain ISO 14001 certificate in addition to the ISO 9001 certificate in 2002.

(2) Observation of Pollution Control Condition

This factory has one line of Nickel/Chromium plating plant with a capacity of 800 m^2 per day. Wastewater from this plant is sent to a centralised wastewater treatment facility in the electroplating park. This plant is pollution free and plans to reduce the volume of wastewater to save the cost of wastewater treatment. Exhaust air from the plant is clean because the plant is equipped with adequate ventilation units for a nickel/chromium plating line and has no steam boiler.

(3) Waste Disposal, Treatment and Recycling

Sludge generated from the plant is sent to an external company for further treatment on commission. No recycling is practiced.

(4) Measures for Productivity Improvement

The post treatment of chromium plating is one target to improve productivity. As a result of poor washing after chromium plating, some additional work to wipe and repair is needed. Customers sometimes complain about defects in the products. Moreover, chromium plating is carried out under undesirable conditions of operating temperature, low speed of plating, etc. These may cause low productivity.

8.3 CP Options in the Model Factory

Existing problematic issues in the factory that need CP measures are summarised as follows:

(1) Reduction of water consumption,
(2) Reduction of electricity consumption,
(3) Improvement of product quality (First step)
(4) Reduction of chemical consumption, and
(5) Improvement of product quality (Second step).

(1) Reduction of Water Consumption

The rinsing water consumption was 600-800 m^3/month, which is not so much as compared with the same industry in Japan. However, the high cost of wastewater treatment had decreased the factory's productivity. Therefore, it was thought that reducing and minimizing the rinsing water consumption without degrading product quality was one of the main objectives for the factory.

For reduction of water consumption, three CP options were worked out as follows:

a. Control of city water flow rate to rinsing tanks

The inlet pressure of city water becomes higher during midnight than in the daytime. Therefore, it is necessary to control the valve operation frequently in order to prevent excess water flowing to the rinsing tanks. However, there are many valves to control and operators sometimes miss or forget to control them. To improve operation and control of the city water flow rate, it was studied and decided that by installing a pressure control valve at the inlet point of city water together with the flow meters at the inlet points of the rinsing tanks, this problem can be solved.

b. Reusing of rinsing water

Rinsing water in Rinsing Tank No. 7 (alkaline treating tanks) was discharged outside the factory as wastewater. However, it was found that this rinsing water could be reused as rinsing water for Rinsing Tank No. 4.

c. Recycling of rinsing water

If the concentration of ionic contaminants in rinsing water can be lowered to a certain level, it is possible to recycle this rinsing water. It was also found that rinsing water from the chromium plating and nickel plating tanks could be recycled by installing an ion exchanger system.

(2) Reduction of Electricity Consumption

Generally, higher suspended solid (SS) concentration found in plating solution will lower product quality through the appearance of burn stains and will also lower the electroplating efficiency. The SS concentration in bright chromium plating solution was too high, and it was concluded that installing a filter unit for this bright chromium plating tank would lower the SS concentration.

(3) Improvement of Product Quality (First Step)

In this factory, a certain percentage of the product had gone out of specification because there were yellow remains and burn stains on the surface. This was a serious problem for the factory. After the factory audit, it was found that the main reason for the problem was the volume of rinsing water used was too low. It seemed that actual operating volume was only 0.1 turn over per hour because measured electrical conductivity values (μ S/cm) of water of the three rinsing tanks were 1000, 200 and 100 ,which were too high. The question of how to rinse the products thoroughly without increasing the rinsing water volume was just objective. There was another reason. The concentration of SS in the bright chromium-plating bath was too high; possibly contributing to the problem with burn stains.

If rinsing operations after the chromium plating process is not sufficient, some yellow stains and burn stains will be seen on the surface of the final products. Therefore, extra work such as wiping the products with cloth in order to remove the yellow remains and burn stains is needed. It was found that the rinsing water in the three rinsing tanks (No.33, 34, 35) became yellow. Electrical conductivity values of these three rinsing water were 1000, 150 and 100 μ S/cm respectively in average. It was thought that these conductivity values could be reduced to less than 50 μ S/cm if CP was introduced, with a chosen ion exchanger system installed to make full recycling of rinse water possible.

(4) Reduction of Chemical Consumption

Reduction of chemical consumption is very important because it will not only reduce wastewater discharge but also increases productivity. Normally, chemicals used in the electroplating factory are lost through the following two routes. One is through the product. Some amount of chemicals in the drag out solution tends to adhere on the surface of the products. The other is through an incomplete chemical reaction itself. For reduction in chemical loss, it is very effective to return the dragged out solution to the original tank. There are various methods in use to return the dragged out solution to the original tank as follows:

In order to reduce the loss of chemicals, it is very effective to return the dragged out solution to the original tank. For example, a spraying system (from Recovery Tank to Nickel Plating Tank) is shown in Figure 8-1 and this is a very easy method. In this case, the method for controlling the accumulated concentration of contamination in the plating tank is very important. Figure 8-1 shows part of the electroplating process at one model plant and it is thought that this reduction method for chemical consumption can be applied at other factories.

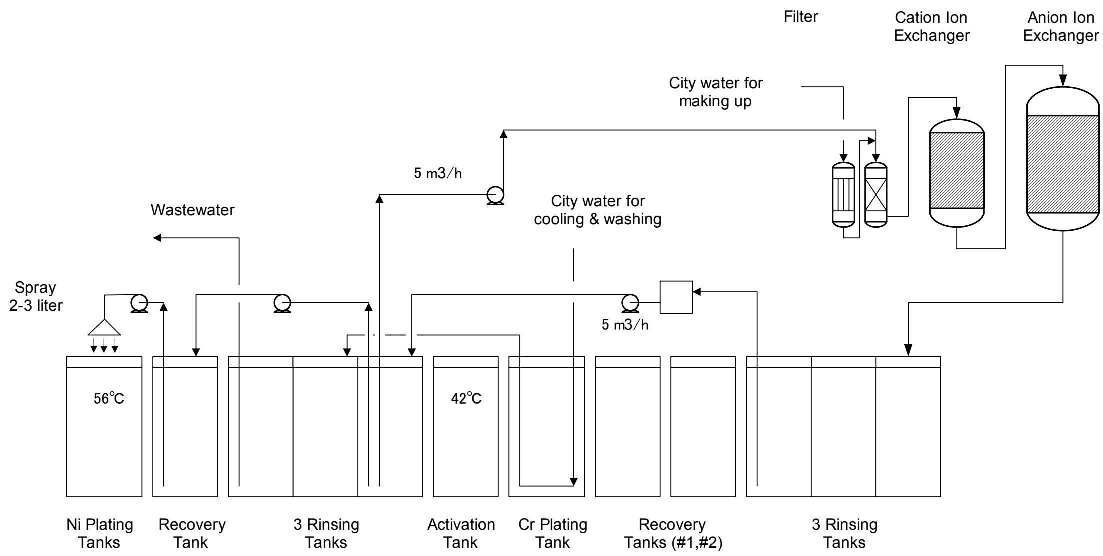

Figure 8-1 One Model of Ideal Recycle System in Ni/Cr Plating Line

(5) Improvement of Product Quality (Second Step)

In the first step mentioned above, only yellow remains and burn stains problems have been explained; however, there are other problems in these electroplating industries. These problems should be studied in future as a target for improvement of product quality. As a recommendation, it is judged that a suitable design and careful maintenance of hooks for raw materials and a suitable shape design for raw materials can give 100% production yield without any yellow remains and burn stains problems.

8.4 CP Measures

8.4.1 Selected CP Measures

Among CP options, the following five CP measures were selected as suitable measures:

(1) Installation of a pressure controller for city water inlet line,
(2) Installation of area flow meters,
(3) Installation of a diaphragm pump,
(4) Installation of a filter unit, and
(5) Installation of an ion exchanger system.

The five CP measures are shown in Figure 8-2.

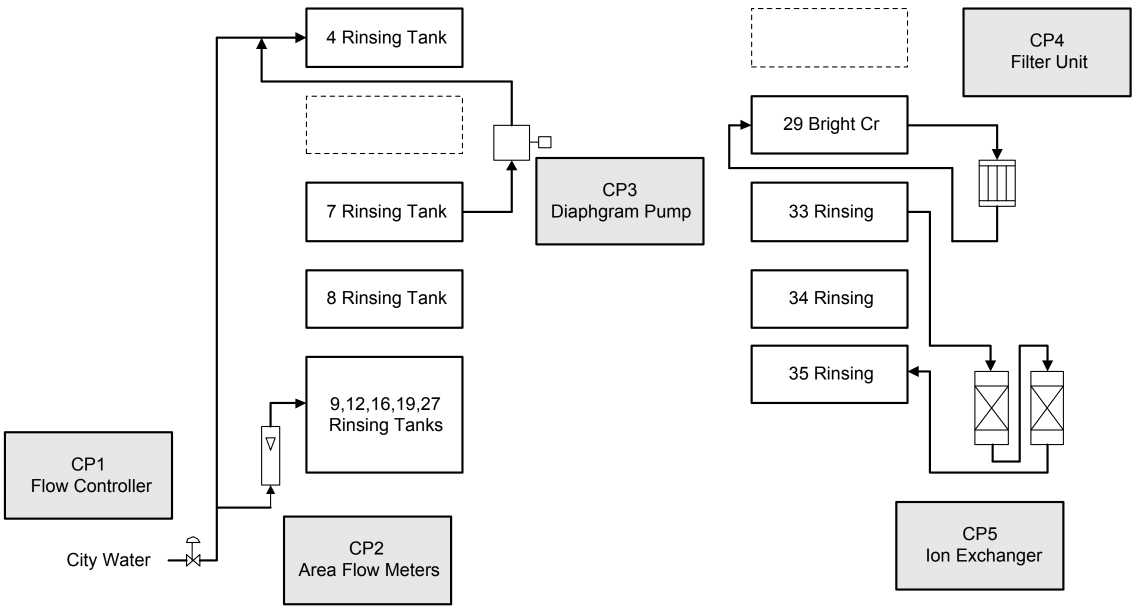

Figure 8-2 Location of CP Measures

(1) Installation of a Pressure Controller for City Water Inlet (CP1)

CP1 is to install a pressure controller at the city water inlet line. Normally, the city water inlet pressure increases during midnight and decreases during daytime as described earlier. This pressure controller controls the outlet pressure and helps to keep a stable flow rate at all times. A flow control valve with 2 inch diameter piping size was installed, so the pressure drop across the valve was about 0.35 kg/cm^2 at the flow rate of 10 m^3/h.

(2) Installation of Area Flow Meters (CP2)

CP2 is to install area flow meters for five rinsing tanks of No.9, 12, 16, 19 and 27 in addition to CP1. Specifications of 4 - 38 l/min. capacity was selected and installed at the city water inlet line for the five rinsing tanks, and the operators could control the water flow rate adequately all the times using these area flow meters.

(3) Installation of a Diaphragm Pump (CP3)

CP3 is to install a diaphragm pump for the purpose of transferring over-flow rinse water from tank No.7 to No.4 for reuse. An air-operated diaphragm pump with a capacity of 52 l/min. was installed. It was confirmed that the pump was operating automatically and batch-wise controlled by a level switch.

(4) Installation of a Filtering Unit (CP4)

CP4 is to install a filtering unit for the bright chromium tank in order to maintain a desirable SS concentration in the tank. A cartridge type of filter with filtering capacity of 9,000 l/h was installed. The filtering mesh was 10 μ m.

(5) Installation of an Ion Exchanger System (CP5)

CP5 is to install an ion exchanger system. This system can make full recovery of rinsing water after bright chromium plating, and can help to improve the final products quality, namely plated surface of the bright chromium.
Refer to Figure 8-3 " Ion Exchanger System for Rinse Water of Chromium Plating".
Two units of feed pump with the capacity of 5,000 l/h were installed for continuous operation. Each volume of the cation and anion resin in the ion exchanger were 450 litre and 700 litre respectively and the filtering mesh was 10 μ m. It is very important to keep a proper regeneration cycle of the ion exchanger to control the total ion concentration in the 2nd recovery tank (Tank No.31).

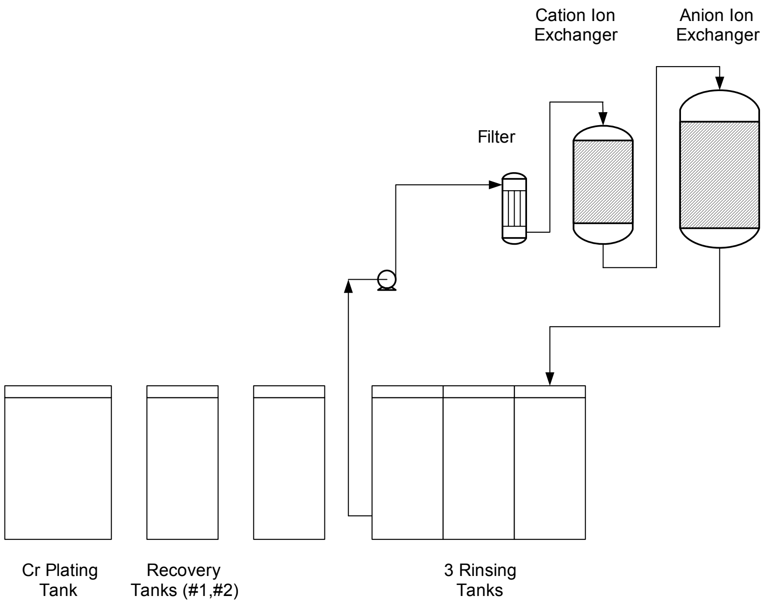

Figure 8-3 Ion Exchanger System for Rinse Water of Chromium Plating

8.4.2 Outline of CP Measures

(1) Layout

Figure 8-4 shows a general plot plan for the introduction of CP1, CP2, CP3, CP4 and CP5.

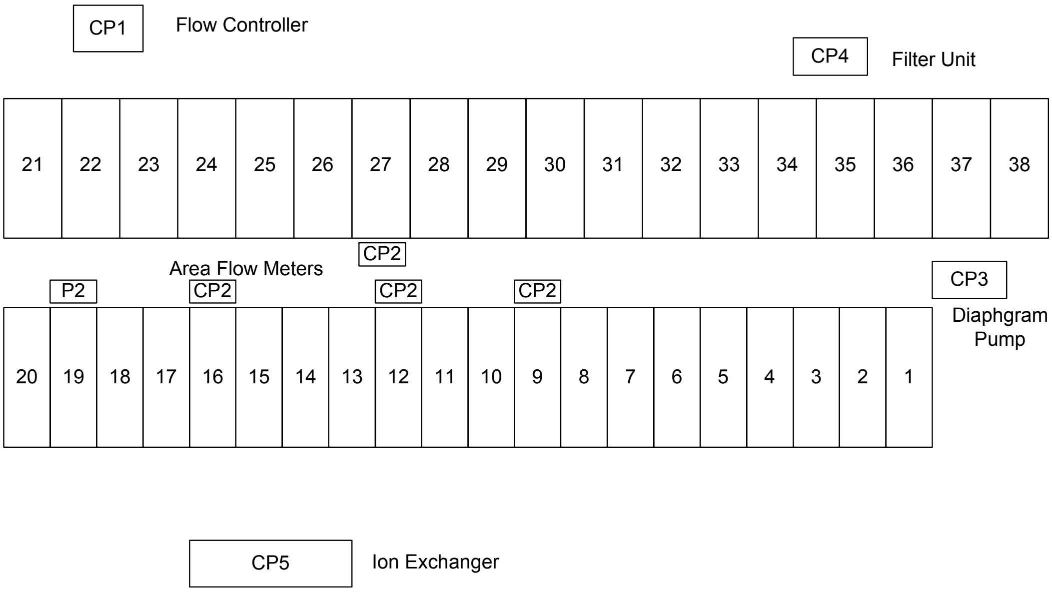

Figure 8-4 Plot Plan for Ni/Cr Electroplating Plant

(2) Basic Flow Diagram

Basic flow diagram for the installation of an ion exchanger system (CP5) is shown in

Figure 8-3. Other flow diagrams for CP1, CP2, CP3 and CP4 are not shown here because they are very simple.

(3) Specification for Major Equipment

Table 8-2 shows the major equipment and its specification.

Table 8-2 Major Equipment and Specification

Major Equipment		Specification
1	Pressure controller	a. Maximum flow rate: 10 m^3/h
2	Area flow meters	a. Flow range: 5-20 litre/minute
3	Diaphragm pump	a. Discharge capacity: 5-20 litre/minute
4	Filtering unit	a. Maximum flow rate: 4,000 litre/h b. Mesh of cartridge: 10 μm c. Continuous operation: more than 2 weeks
5	Ion exchanger system	a. CrO_4^{2-}, SO_4^{2-}, F^- and Cl^- : be removed b. Return water from tank No.30 to Cr plating tank: 3 % every day c. Liquid replacement interval of tank No. 30 and 30 : one year d. Maximum surface area plated: 80,000 dm^2/day e. Operating days: 22 days/month f. Regeneration cycle: once/month at least g. Average concentration of Cr as CrO_3: 200 g/litre h. Maximum flow rate: 2,000 litre/h i. Conductivity of treated water: 5 μS/cm

(4) Expected Effects

Total cost reduction of RM93,000 per year was expected as follows:

a. Reduction of rinsing water and city water by 6%: RM9,000 per year
b. Reduction of labour cost for additional works to wipe and repair final product: RM84,000 per year

After installation of an ion exchanger system for the post chromium plating rinsing tank, it was expected that the rinsing effects would be increased and the frequency of off-specification products decreased.

(5) Estimated Investment Cost

The total investment cost was roughly estimated at RM326,000 as follows:

a.	Pressure controller	I set	RM5,000
b.	Area flow meters	5 sets	RM15,000
c.	Diaphragm pump	1 set	RM5,000
d.	Filtering unit	1 set	RM71,000
e.	Ion exchanger system	1 set	RM230,000
	Total		RM326,000

(6) Schedule

Refer to CHAPTER 7 "Implementation Schedule".

For Metal Polishing Industries Sdn. Bhd., the completion of construction work was scheduled for the end of November 2001, and the final test operation was also performed at the end of November 2001 on schedule.

8.5 CP Investment

The total investment for the CP introduction resulted in RM216,000 as shown in Table 8-3.

Table 8-3 Investment for CP Measures

No.	Item	Quantity	Amount (RM)
CP1	Installation of a pressure controller for city water inlet	1 set	5,000
CP2	Installation of area flow meters	5 sets	10,000
CP3	Installation of diaphragm pump	1 set	9,000
CP4	Installation of a filtering unit	1 set	87,000
CP5	Installation of an ion exchanger system	1 set	105,000
Total			216,000

In these investments, all cost of design, equipment & machinery, construction material, transportation, construction, operation manual, commissioning & training and spare parts are included.

8.6 Performance Confirmation

Only a few months after CP introduction, the apparent benefits were confirmed for wastewater treatment cost saving, city water consumption saving, electricity consumption saving and labour cost saving as described below.

(1) Impurity Ion Concentration in Rinse

After the introduction of CP5 (an ion exchanger system), the concentration of impurity

ions and the electrical conductivity in rinsing water were dramatically decreased as shown in Tables 8-4 and 8-5 respectively.
Through these improvements, product quality improvement was achieved.

Table 8-4 Concentration of Typical Ions in 3rd Rinsing Tank (No.35)

Unit: mg/l

Sampling Date	Parameter					Note
	Cr^{6+}	$Cr3^{+}$	Ni^{2+}	SO_4^{2-}	Cl^{-}	
14 December 2000	5.0	0.72	0.66	16.2	-	
21 February 2001	4.4	-	-	-	-	
21 November 2001	4.62	0.71	0.43	4.7	0.3	Before CP5 start
21 November 2001	0.05	0.13	<0.0	<1	<0.1	5 hours after CP5 start
28 November 2001	<0.0	<0.0	<0.0	<1	<0.1	

(2) Electrical Conductivity in Rinsing Water

The water in rinsing tanks became very clear and transparent, and their electrical conductivity value reduced as shown in Table 8-5.

Table 8-5 Electrical Conductivity in Rinsing Water

Unit: μ S/cm

Sampling Date	1st Rinsing Tank	3rd Rinsing Tank	Note
14 December 2000	140	90	
21 February 2001	1,500	100	
20 November 2001	125	110	
21 November 2001	1,140	42	Just before CP5 start
21 November 2001	100	20	1 hour after CP5 start
21 November 2001	20	1	6 hours after CP5 start
23 November 2001	20	2.5	
26 November 2001	20	1	
28 November 2001	20	1	
30 November 2001	20	1	
16 January 2002	45	1	
23 February 2002	55	1	

Note: Design value of conductivity value in 3rd rinsing tank is below 50μS/cm.

8.7 Reduction of Production Cost and Increased Running Cost

From performance confirmation data, reduction of production cost and increased running cost were confirmed as follows:

(1) Reduced wastewater treatment fee +RM1,996/month
(2) Reduced city water consumption +RM234/month

(3)	Reduced electricity consumption	+RM19/month
(4)	Reduced labour cost	+RM4,400/month
(5)	Increased productivity	+RM6,350/month
	Sub-total	+RM12,999/month
(6)	Increased running cost	
a.	Regeneration of resins in the ion exchanger system	
(i)	Chemical consumption cost-1	- RM17.5/month
(ii)	Chemical consumption cost-2	- RM13.5/month
(iii)	Resin replacement cost	- RM723/month
(iv)	Resin addition cost	- RM170/month
b.	Cartridge replacement cost	- RM45.5/month
	Sub-total	- RM969.5/month
	Total	**+RM12,029/month**

Outline of reduction of production cost and increased running cost are as follows.

(1) Reduction of Wastewater Treatment Fee

Wastewater treatment cost was reduced to about one third of the original cost as shown in Table 8-6. It was thought that the ratio of the cost reduction would be almost constant and had no relation to the volume of wastewater discharge. In the chromium series, wastewater discharge of 5m^3 was still occurring, and it was judged that this discharge came from replacing the rinsing water in the two recovery tanks (No. 30 and No. 31). Finally, it can be said that the first target was sufficiently achieved.

Table 8-6 Wastewater Treatment Cost before and after CP Introduction

Unit: RM/month

	Before CP (November 2001)	After CP (December 2001)	Note
Chromium	465 (14m^3)	279 (5m^3)	By CP5
Acid	666 (34m^3)	344 (16m^3)	By CP1and CP2
Alkali	2,058 (133m^3)	570 (37m^3)	By CP3
Total	**3,189** (181m^3)	**1,193** (58m^3)	

Table 8-6 indicates that reduced wastewater treatment fee became the following:

3,189 - 1,193 = **RM1,996/month**

(2) Reduction of City Water Consumption

The volume of wastewater discharge is almost equal to city water consumption. City water consumption was reduced to one third of original volume (181 to 58 m^3) as shown in Table 8-6.

Now,

Unit price of city water: RM1.9/m^3

Reduced city water: 181 - 58 = 123 m^3/month

Therefore, cost saving for city water consumption was:

(181 - 58) m^3/month x RM1.9/m^3 = **RM234/month**

(3) Reduction of Electricity Consumption in Bright Chromium Plating

Operating conditions in the bright chromium plating was as follows;

Power supply: 4,000 ampere (A), 6 volt (V) and 2 min. for one cycle

One tact: 7 min.

Operating hours: 16h/day

Operating days: 22day/month

Unit price of electricity: RM0.26/kWh

Saved electricity: 3 % *1

Therefore, electricity saving cost was calculated as follows:

(4,000A x 6V x 2/60 x 60/7 x 16h/day x 22day/month) x 0.26RM/kWh/1,000 x 0.03 = **RM19/month**

*1: Electricity consumption was reduced by introducing CP4 and the saved electricity ratio was confirmed by the factory.

(4) Reduction of Labour Cost through Product Quality Improvement

It was also confirmed by the factory that labour was reduced by 3 workers and the yellow remains and burn stains problems on the final products were improved by introducing CP4 and CP5. It was thought that the plated quality was improved through CP4 and the full recycling of rinse water in CP5 that contributed to this matter dominantly. Finally, the yellow remains and burn stains problems were reduced from 30-35% to 10-15% and productivity was increased from 65-70% to 90-95%. The labour cost saved for 3 workers was calculated as follows;

Unit labour cost: RM4.2/h

Operating hours: 16h/day

Operating days: 22day/month

Therefore, cost saving is:

16h/day x 22day/month x 3person x 4.2RM/h/worker = **RM4,400/month**

(5) Increased Productivity

In addition to the improvement of final product quality, it was reported by the factory that 5% of total factory productivity was increased by improvement of rinsing water. Before CP introduction, a small amount of liquid chromium was remained on the surface of racks and bars that hung the products, and operators had to handle the bars with great care not touch toxic chromium. Those operations were creating a loss of time. After CP introduction, the operations of changing bars were increased from 103 units to 108 units per day and profit was increased as follows:

Increased profit = variable profit x increased productivity

Variable profit = sales x variable profit ratio

The sales in 2001 was RM3,294,000 and variable profit ratio was 50%. Therefore,

Variable profit = 3,294,000 x 0.5 = RM1,647,000/year, and

Increased profit = 1,647,000 x (108-103)/108 = RM76,250/year

= RM6,350/month

(6) Increased Running Cost

By introducing CP, running cost for the following increased:

a. Regenerating of resins in the ion exchanger system for CP5, and
b. Replacing of cartridge filters for CP4 and CP5.

There were other increases in running cost such as electricity consumption for motors in the filtering unit and also in the ion exchanger system. However, it was thought that these increases were small and could be neglected. Therefore, the total increased running cost was calculated as follows:

a. Increased running cost for regenerating of resins in ion exchanger system

Resins are regenerated by using chemicals and it is necessary to replace deteriorated resins. Therefore, increased running cost for regeneration was calculated item by item as follows:

(i) Chemical consumption cost (for cation resin):

Cation resins are regenerated by using of NaOH every two month, and;

Resin volume:	700 litre
Required NaOH equivalent:	1.0 equivalent/litre-resin
Equivalent of NaOH:	40g-NaOH/ equivalent

NaOH concentration: 0.33

Unit price of NaOH: RM0.6/kg

Therefore, required NaOH is:

700 litre x 1.0 eq./litre x 40 g/eq. = 28,000 g

and required cost is:

28,000/1,000 x 1/0.48 x RM0.6/kg = RM35/2 month = **RM17.5/month**

(ii) Chemical consumption cost (for anion resin):

Anion resins are regenerated by using of H_2SO_4 every two month, and:

Resin volume: 450 litre

Required H_2SO_4 equivalent: 1.0 eq./litre-resin

Equivalent of H_2SO_4: 36g-NaOH/eq.

H_2SO_4 concentration: 0.33

Unit price of H_2SO_4: RM0.55/kg

Therefore, required NaOH is:

450 litre x 1.0 eq./litre x 36 g/eq. = 16,200 g

and required cost is:

16,200/1,000 x 1/0.33 x RM0.55kg = RM27/2 month = **RM13.5/month**

(iii) Replacement cost:

Both resins deteriorate day by day and it is necessary to replace all of them every two years, and:

Anion resin volume: 700 litre

Unit price of anion resin: RM19/litre

Cation resin volume: 450 litre

Unit price of cation resin: RM9/litre

Therefore, required cost is:

700 litre x RM19RM/litre + 450 litre x RM9/litre

= RM17,350/2 years = RM8,675/year = **RM723/month**

(iv) Additional cost

Both resins are also consumed day by day and it is necessary to add them before replacement. It is assumed that the consumption rate is 1.0 % of total resin volume per month. Therefore, required cost is:

(700 litre x RM19RM/litre + 450 litre x RM9/litre) x 0.01

= **RM170/month**

b. Increased running cost for replacement of cartridge filters

It is necessary to replace cartridge filters every two month and:

Replacement cost: RM91/2 month

Therefore, required cost is:

(RM91/2 month)/2 = **RM45.5/month**

8.8 Financial Analysis

5 CP measures were introduced in the model factory as described earlier. CP1, CP2 and CP3 were introduced for the purpose of decreasing city water consumption and wastewater discharge. CP4 was introduced for decreasing electricity consumption and for the reduction of manpower through the improvement of product quality through use of a filtering system. CP5 was also introduced for the reduction of manpower through improvement of product quality and for decreasing wastewater discharge and city water consumption through recycling of ion-exchanged water through introduction of an ion-exchanger system. The model factory started to make independent effort to reduce city water consumption and wastewater discharge with recommendations made by SIRIM and the Study Team, just after they decided to introduce CP measures. As a result, city water consumption and wastewater discharge were reduced dramatically before the introduction of CP equipment; after the introduction of CP equipment, further reduction was achieved.

Actual investment, cost saving and increased cost of each CP measure are shown in Table 8-7 and the calculated POT and IRR are shown in Table 8-8. The calculation for POT and IRR in total investment shown in Table 8-9 was made by using the data in Table 8-7 using methodology explained in 5.4.3.

Each of CP1, CP2 and CP3 is a small investment and each purpose is the same. Furthermore it was not easy to get the data for each CP measure separately; therefore evaluation of profitability was carried out totaling CP1, CP2 and CP3 to a group.

Table 8-7 Investment and Cost Saving Data

		CP1	CP2	CP3	CP4	CP5	Total
Investment	RM	5,000	10,000	9,000	87,000	105,000	216,000
Cost saving	RM/y		24,000		21,000	110,000	155,000
Increased cost	RM/y		0		1,000	10,000	11,000

Table 8-8 POT and IRR for CP Measures

		CP1 to CP3	CP4	CP5	Total
POT	year	1.3	5.8	1.4	2.1
IRR	%/year				51

Table 8-9 Calculation for POT and IRR in Total Investment

1,000RM

Year	0	1	2	3	4	5	6	7	8	9	10
Investment	216										
Cost saving		155	155	155	155	155	155	155	155	155	155
Increased cost		11	11	11	11	11	11	11	11	11	11
Interest		13	6	0	0	0	0	0	0	0	0
Income tax		21	36	38	38	38	38	38	38	38	38
Net cash flow	-216	110	102	106	106	106	106	106	106	106	106
Depreciation		60	17	17	17	17	17	17	17	17	17
Loan balance	216	106	4	0	0	0	0	0	0	0	0

The result of CP introduction was analysed financially as follows.

The investment costs for CP1, CP2 and CP3, are smaller without any additional operation cost and achieved good profitability though the annual cost saving is not much. POT is 1.3 years, and it was shorter if the model factory had consumed as much water as indicated when CP measures were planned.

This shows that in addition to the introduction of CP measures it is very important to familiarise employees and operation of the existing facilities with CP concepts. When CP measure is spread to other companies, awareness about CP should be improved first.

The profitability of CP4 is a little insufficient because POT is 5.8 years. Although saving of electricity is small, the reduction of three workers largely increased profitability. Therefore, if the model factory can further reduce more manpower, POT will become shorter.

CP5 shows very good profitability with POT at1.4 years. In the profitability check, it was found the factory's productivity increased by 5 % through improvement of working environment by CP5. So, although the reduction of three workers represents a large amount of money, the increased productivity through CP5 generates much more profits. CP5 can be recommended to any company in the same situation as the model factory because it is not only profitable but also efficient in the improvement of the working environment.

This demonstration project achieved POT 2.1 years and IRR 51 %, indicating that the project is a good investment.

8.9 CP Benefit

It was confirmed that the model factory could reap the following benefits through the five CP measures:

(1) Through the reduction of wastewater treatment fee, labour cost, city water and electricity consumption, the model factory could decrease production cost by RM144,350 per year though some amount of running cost increased.

(2) From the financial analysis result, it can be said that this project is a good investment.

(3) CP introduction in the factory generated many positive benefits that form a good case for the promotion of CP in Malaysia. As described before, this company is going to obtain ISO 14001 certificates in addition to ISO 9001 in 2002, and they had already initiated action to reduce city water and electricity consumption just after the factory was selected as a model factory. It was realised that CP introduction had became a strong motivational force that encouraged factory managers to improve productivity all round. Now, the factory managers are continuously thinking of many CP options and they plan to put them into practice in order to increase the productivity and to improve product quality.

8.10 Recommendations

Metal finishing and electroplating are important technologies when considering decoration and anti-corrosion of metal products. In countries aiming to become technology-oriented countries, metal finishing and electroplating is essential to the discussion of thin film production technologies. In contrast, wet surface finishing is dangerous because contributes to environment pollution by discharging harmful wastes and wastewater containing several chemical substances. To minimise contamination, strong government leadership over these industries is required. Malaysian enterprises are mostly self-reliant and vigorous, however, at the same time; it seems difficult to gather these enterprises into an industrial organisation.
The following policies are recommended to the country, the industry and to enterprises.

(1) Expansion of the existing industrial organisation of metal finishing and

electroplating, and installing a research group in the organisation,
(2) Establishment of public consulting system,
(3) Activation of electroplating parks in the country, and
(4) Establishment of a proper environmental standard and observance of the standard.

The details of these recommendations are as follows:

(1) Expansion of the existing industrial organisation for metal finishing and electroplating, and installing a research group in the organisation

An industrial organisation of metal finishing and electroplating is already founded and is active. But membership is very low and most surface finishers and platers do not belong to the organisation. Therefore, it is necessary for the organisation to increase membership and to study and discuss environmental problems in metal finishing and electroplating industry by themselves. These study and discussion are effective for environment improvement. Moreover, it is recommended to install a research team in the organisation for solving their environmental problems. Independent research to solve these serious problems will accelerate environment improvement in this country.

(2) Establishment of public consulting system

Most of the audited factories do not employ or allocate technical staff. One company was very active and determined to improve productivity and had already initiated actions to reduce city water and electricity consumption just after it had been selected as a model factory. However, its methodology to reduce city water and electricity consumption was not entirely correct, because it was causing a degradation of product. The electroplating process is operated with emphasis on electrochemistry. Through advice from SIRIM and the Study Team, the factory could improve the productivity and product quality on their own. This company employed a few college graduates after CP introduction who developed CP options continuously.

In most cases, chemicals suppliers are playing the technical role in the electroplating factories because the factories do not have sufficient margin to employ or allocate technical staff. Therefore, if it is not possible to employ or allocate technical staff, the establishment of a public consulting system for metal finishing and electroplating technology is recommended.

(3) Activation of electroplating parks in the country

During the factory audits, there have been many chances to visit Bukit Kemuning Plating Park which is located in Selangor and is well designed. However, communication among the member companies in the electroplating park is rare, and the original plan of the industrial park has not been fulfilled. It is advantageous that an electroplating park should be managed to improve the relationships among electroplaters in the park. Information exchange among the members in electroplating parks is an indispensable element for improvement of productivity and production and pollution protection technique.

(4) Establishment of a proper environmental standard and observance of the standard

The environment standards in Malaysia are established based on sufficient research, and are excellent in their content. However, monitoring by SMIs is rare and violations against standards are sometimes overlooked.

It is recommended that after a regulation clause with a time limit is established, strict penal regulation be applied to regulation violators. As regulations shift to become more rigorous, each company will have to improve its facilities to conform the regulations within the time limit. Thus each company's level of pollution protection will gradually be improved. To overlook violations for a long time is risky, resulting in delay of environmental improvement measures.

Attachment

Surveyed Factories for Selection of Model Factory

The outline of the surveyed factories is described below.

1. Metal Polishing Industries Sdn. Bhd.

Refer to Section 8.2.

2. Persahaan TGB Sdn. Bhd.

Refer to Chapter 9.

3. E-Coat Sdn. Bhd.

3.1 Present Status

(1) Observation of pollution control condition

The factory is located in Bukit Kemuning Electroplating Park, which is facilitated with a centralised wastewater treatment plant; therefore the company has no wastewater treatment facility of its own. Although an exhaust gas system is not installed, the factory meets environmental regulations in Malaysia, because there is no combustion gas. There is confusion in separating wastewater into 4 categories. If wastewater of different category is mixed, the centralised wastewater treatment plant cannot treat the wastewater adequately. As a result, harmful substances are discharged from the plant without any treatment. Strict separation of wastewater is necessary.

(2) Waste disposal, treatment and recycling

Sludge at the bottom of wastewater pit and spent treatment solution are consigned to the centralised wastewater treatment plant of Kualiti Alam Sdn. Bhd. as industrial wastes. Recycling of waste is not practiced at all.

(3) Measures for productivity improvement

For increasing productivity, rinsing time is reduced to the minimum that product quality can allow.

(4) Others

For heat energy saving, low temperature treatment methods for processing have been adopted. In this factory treatment tanks used at high temperature are for degreasing, electro-degreasing and hot water rinsing. The preset temperature at the tanks is lower than that in the original specification. Heat insulation is provided for treatment tanks.

3.2 CP Options

(1) Maintenance of jigs and racks

The rejection ratio of the products exceeds 10% in a particular product. If jigs and racks are appropriately managed and maintained, no problem requiring re-treatment would occur during the plating. Elimination of re-treatment can reduce the excess cost of electricity, fuel, water, chemicals, waste treatment, labour power and substrates, and would additionally reduce late deliveries.

(2) Strict separation of the wastewater

The wastewater is separated into 4 categories, but sometimes becomes mixed. The wastewater treatment plant is operated based on the assumption that wastewater is strictly separated. If chromium is contained in the acid or the alkaline wastewater, chromium will leak into the treatment plant effluent water.

(3) Installation of air exhaust and gas unit

Installing an exhaust treatment system will improve working conditions and extend plant life because the mist of corrosive chemicals will not attack the equipment in the plant.

4. Aceloy Sdn. Bhd

4.1 Present Status

(1) Observation of pollution control condition

The factory is located in Bukit Kemuning Electroplating Park, which is facilitated with a centralised wastewater treatment plant; therefore the company has no wastewater treatment facility of its own. An exhaust system is not installed. This factory meets the environmental regulations in Malaysia.

(2) Waste disposal, treatment and recycling

Sludge at the bottom of wastewater pit and spent treatment solution are consigned to the centralised wastewater treatment plant of Kualiti Alam Sdn. Bhd. Recycling of waste is not practiced at all.

(3) Measures for productivity improvement

The factory was newly built and had not developed operations to the extent that sufficient trial for productivity improvement was possible.

(4) Others

For heat energy saving, low temperature treatment methods for processing have been adopted. In this factory, high temperature treatment tanks are used for degreasing, electro-degreasing and hot water rinsing. All tanks used at high temperature are insulated to prevent heat loss through the wall of tanks. However, an off-line pre-degreasing tank is made of plastics and has no heat insulation and heat leakage is a problematic issue in the factory.

4.2 CP Options

(1) Installation of exhaust system

Installing an exhaust treatment system will improve working conditions and extend plant life because the mist of corrosive chemicals will not attack the equipment in the plant.

(2) Adoption of non-toxic blue chromating with chromium trivalent

By using the blue chromate process using chromium trivalent, there will be no contamination with chromium hexavalent. In particular as hot rinsing water will not contain chromium hexavalent, the rinsing water of blue chromating can be discharged to the alkaline pit.

5. Malaysian Electroplating Technology Sdn. Bhd.

5.1 Present Status

(1) Observation of pollution control condition

The factory has good quality waste treatment facilities, however their running cost is too high to use for daily operation. At present, installation of new wastewater treatment system is planned. Wastewater containing toxic chromium hexavalent is discharged without any treatment. An exhaust system is installed with a scrubber and is used during operations.

(2) Waste disposal, treatment and recycling

Sludge at the bottom of wastewater pit and spent treatment solution are consigned to Kualiti Alam Sdn. Bhd. Recycling of waste is not practiced at all.

(3) Measures for productivity improvement

An acidic zinc plating method that has high productivity is adopted. This zinc plating bath is not toxic, and drag-out from plating bath is less than a zincate plating bath. At present the effect of acidic zinc cannot be observed because the production volume is small.

(4) Others

For the energy saving, treatment tanks used at high temperature are for degreasing, electro-degreasing and hot water rinsing. The bath temperature of degreasing is 70℃, which is higher than in other factories. It is recommended that other degreasing agent be selected for lower temperature operation. Actually, the preset temperature is lower than that in the original specification. Heat insulation is provided for treatment tanks.

5.2 CP Options

(1) Installation of an exhaust system

Installing an exhaust system will improve working conditions and extend plant life because mist from corrosive chemicals will not attack equipment in the plant.

(2) Introduction of the blue chromate process using chromium trivalent

By using the blue chromate process with chromium trivalent, there will be no contamination with chromium hexavalent. In particular, hot rinsing water will not contain chromium hexavalent. The rinsing water of blue chromating can be discharged to the alkaline pit.

6. Chemobright Industries Sdn. Bhd.

6.1 Present Status

(1) Observation of pollution control condition

The production volume in the factory, an anodizing plant, is small. Chemical polishing is central to operations. Concentrated phosphoric acid and nitric acid are used in the process, therefore NO and NO_2 gases are generated during the treatment. The gases are gathered through an exhaust system and washed in a scrubber. Wastewater is gathered, neutralised and discharged. According to the results of rinsing water analysis, the factory meets the Malaysian effluent standard-B.

(2) Waste disposal, treatment and recycling

Sludge at the bottom of wastewater pit and spent treatment solution are consigned to Kualiti Alam Sdn. Bhd.. Recycling of waste is not practiced at all.

(3) Measures for productivity improvement

Production volume is too small in the factory to improve productivity.

(4) Others

For energy saving, treatment baths used at high temperature are for chemical polishing and dyeing. Natural gas is used as fuel to heat these solutions in order to reduce heating cost. Alkaline etching and sealing are operated at room temperature for reducing cost. The stainless steel tanks are not covered with an insulator. Bright polishing of the stainless steel tank surface and the low heat conductivity of stainless steel will help to prevent the heat irradiation from the tanks.

6.2 CP Options

(1) Alkaline chemical polishing

Alkaline chemical polishing technology has been developed. As advantages of the technology are not yet proven, it is recommended that related information be collected in preparation for future development.

(2) Thermal insulation on chemical polishing and dyeing tanks

The treatment tanks for chemical polishing and dyeing are made of thin stainless steel. Thermal insulation of these tanks can prevent heat loss from the tank surface.

(3) Coating the floor with acid-resistant paint or glass

Acid damages concrete floors. To protect the concrete floors from acid, it is recommended that the floors be coated with acid-resistant paint or permeable liquid glass. Through use of these coatings the life of the concrete floors will be very long even under acidic conditions.

(4) Reusing of rinsing water at other rinsing tank

It is possible to reuse rinsing water in other rinsing tanks to reduce total water consumption.

Demonstration Project for Cleaner Production in Electroplating Sub-sector

Model Factory: Metal Polishing Industries Sdn. Bhd.

Study Tour (27 June 2002)

Measures for the Reduction of City Water Consumption

Pressure Control Valve to
Control City Water Inlet Pressure

Area Flow Meter

Diaphragm Pump for Rinsing Water Reuse

Filter for Chrome Plating Bath

Ion Exchanger System for Rinsing Water Recovery

CHAPTER 9

DEMONSTRATION PROJECT IN THE METAL FINISHING AND ELECTROPLATING SUB-SECTOR-2

CHAPTER 9 DEMONSTRATION PROJECT IN THE METAL FINISHING AND ELECTROPLATING SUB-SECTOR-2

Model Factory: Perusahaan TGB Sdn. Bhd.

9.1 Factory Survey Result (General)

Factory survey result in metal finishing and electroplating sub-sector is described in Chapter 8.

9.2 Status of the Selected Model Factory before CP Introduction (Perusahaan TGB Sdn. Bhd.)

(1) Outline of the Factory

Perusahaan TGB Sdn. Bhd. is in the business of anodizing aluminum. It has long tanks of over 6 meters in length, and anodizing extruded aluminum sections is its main job. The plant was installed about 20 years ago, and designed under an old concept. In 1997, the present owner of the company had taken over the old factory. Therefore, there were many areas to be improved on. The present owner is enthusiastic to improve his anodizing line and to expand his business.

(2) Observation of Pollution Control Condition

Toxic materials are not used in this plant. Wastewater is gathered and discharged after neutralisation, coagulation and filtration in the wastewater treatment unit. The effluent wastewater meets the Malaysian Regulation (Sewage and Industrial Effluent for Standard B). However, pH value of the discharged water fluctuates and occasionally shows above standard values. It was presumed that this was because of insufficient maintenance of the pH sensor. After the factory survey the old pH sensor was replaced with a new one and periodic maintenance of the pH sensor was scheduled.

An exhaust system was installed for alkaline etching tanks but a scrubber is not yet installed. However, the exhaust system is too old to work well. The atmospheric contaminants generated from the factory are acidic and alkaline mists. It is thought that the installation of a scrubber will be effective to reduce the exhausted mists. Therefore, it is necessary to install a scrubber and a new exhaust system for anodizing and etching tanks.

(3) Waste Discharge, Treatment and Recycling

Sludge generated by neutralisation at the wastewater treatment unit is discharged. Its main component is aluminum hydro-oxide. The amount of sludge was 11.7 tons in 2000. Recycling of caustic soda for etching and sulfuric acid for anodizing is not practiced at all because recycling would not be profitable due to the small amount of production

(4) Measures for Productivity Improvement

In this factory a longer than usual anodizing time is necessary to obtain required film thickness. The voltage meters attached on the rectifiers do not show the maximum voltage of each rectifier, and it means that each rectifier cannot supply its full capacity current. Electrolysis sometimes stops because of bad contact between anode beams and anode stands. A long alkaline-etching time is also necessary to obtain the surface appearance to be required by customers.

These two processes were bottlenecks for improving the productivity in this anodizing line. As a measure for improvement, an installation of an etching tank was executed by the company after the audit.

(5) Others

Status of energy and water consumption was as follows.

a. Energy consumption

In the factory, heating is required only for the degreasing and alkaline etching operations. A room temperature sealing technology is adopted. A boiler is not installed in the factory. Electric energy conservation is important in the factory. Bus bars and anode beams were showing higher temperatures than usual. It was supposed that insufficient cross-section area for passing current and inadequate contacts at connecting points and at the anode stand were causing heat release and energy loss. In the anodizing process, electricity was supplied to one side of the anode beams, so the anode film thickness was not same as shown in Figure 9-1. In addition, the anodizing operation needed longer time than usual. This problem also seemed to cause an energy loss.

b. Water consumption

Rinsing water consumption was about 1,500 tons/month. Water flow in the rinsing tanks was insufficient and the water was stagnant at the bottom of the rinsing tanks. Water agitation to support rinsing was not sufficient. Consequently water was not used effectively. Additionally, recycling or reuse of wastewater was not achieved at all.

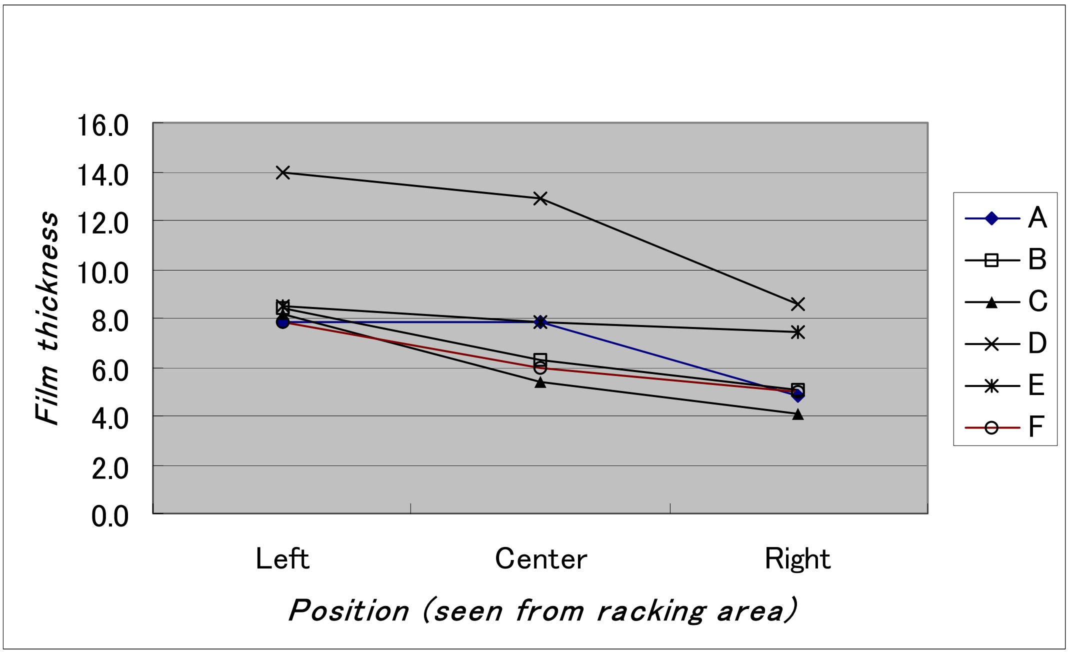

Figure 9-1 Anodic Film Thickness Deviation before CP Introduction

9.3 CP Options in the Model Factory

Present problematic issues in the factory that need CP measures are summarised as follows.

(1) Reduction of electricity consumption,
(2) Reduction of water consumption, and
(3) Acceleration of alkaline rate.

(1) Reduction of Electricity Consumption

Rising temperatures at wires from rectifiers to tanks causes energy loss. Up to now, due to the insufficient understanding operators had overlooked the invisible electric energy loss. Anodizing is a chemical reaction induced by electrical energy. Though much electricity is spent in anodizing, the loss is not often recognised. Anodizing time is shortened by improving electric current distribution and improvement in productivity can be expected.

There were many items to be improved from the viewpoints of CP, and they were categorised into electricity use, water use, product quality and working environment as mentioned below:

a. Rearrangement of all components between rectifiers and anodized parts such as the electric current capacity of bus bars, wire connections, electricity supply from both sides of tanks, electricity supply for anode and cathode beams. Renewal of anode and cathode beams.

b. Introduction of a showering method for anode beams in the rinsing process

(2) Reduction of Water Consumption

As most water is consumed for the rinsing operation, it is necessary to control water flow for the reduction of rinsing water. Proper water flow in the rinsing tanks enables washing operations with smaller amounts of water. For this purpose, installation of water supply piping into rinsing tanks, agitation of water in rinsing tanks and drainage of some of rinsing water is necessary. In addition, recycling of rinsing water into other rinsing tank is possible.

Specific measures are as follows:

a. Installation of water supply piping into rinsing tanks,
b. Repair of air agitation pipes in tanks,
c. Introduction of showering method for anode beams in rinsing process,
d. Installation of over-flow gutters, and
e. Introduction of counter current system (Send back the used rinsing water to another rinsing tank).

(3) Acceleration of Alkaline Etching Rate

To reduce alkaline etching time, new additives to the etching solution is expected to accelerate etching rate. However, if the appearance of products created using the new solution is different from the present one, there is a possibility that customer approval will not be obtained. Based on advice and information given by SIRIM and the Study Team to accelerate etching rate, the company is making efforts to improve the etching rate.

9.4 CP Measures

9.4.1 Selected CP Measures

After the detailed factory survey and study, the following six CP measures were selected for the purpose of reduction of electricity and water consumption and improvement of product quality:

(1) Rearrangement of wiring between rectifiers and tanks (CP1),
(2) Installation of newly designed anode stands (CP2),
(3) Replacement of anode beam sets (CP3),
(4) Refreshment of cathodes (CP4),

(5) Improvement of rinsing facility (CP5), and
(6) Introduction of counter-current system (CP6).

Five measures (CP1, CP2, CP3, CP4, and CP5) were selected for reduction of electricity consumption. Their main purposes are to eliminate the electrolysis voltage drop between rectifiers and anodizing tanks and to reduce the film thickness deviation in products through which shortening of anodizing time can be expected.
Two measures (CP5 and CP6) were selected with the purpose of increasing the efficiency of water rinsing and to reduce the amount of rinsing water through recycling. For the acceleration of alkaline rate, specific measures were not selected, because it was difficult to introduce CP measures within a limited period.

The outline of each CP measure is explained as follows.

(1) Rearrangement of Wiring between Rectifiers and Tanks (CP1)

Adequate cross-section area and connection of bus bars can reduce the electrolysis voltage. Connection of bus bars and anode stands or cathodes is important for the same reason. The reduction of electrolysis voltage means the reduction of the electricity consumption. This measure consists of:

a. Improvement of electric capacity of the bus bar,
b. Reduction of electric contact resistance, and
c. Electricity supply from both sides of tanks.

Existing and additional bus bars are to be used for these measures.

(2) Installation of Newly Designed Anode Stands (CP2), and
(3) Replacement of Anode Beam Sets (CP3)

By installation of new anode stands on both sides of each anodizing tank in addition to the rearrangement of wiring and supply of electricity to both sides of the anode beams, it is possible to attain uniformity in film thickness and to shorten anodizing time. Renewal of anode beams and anode stands can also eliminate electrolysis interruption. This measure consists of:

a. Installation of anode stands, and
b. Improvement of contact point between anode stands and anode beams.

New anode stands can set the anode beams at the correct position. Anode beams and splines are also newly designed and setting or unsetting operations becomes easy.

(4) Refreshment of Cathodes (CP4)

Cathodes also affect electric current distribution. Suggested measures are addition of electricity supply from sides, adequate surface area, correct positioning, and protection from corrosion. At the same time, the allocation of anodes and cathodes in the anodizing tanks shall be corrected. There are three types of anodizing tanks in size but the allocation of electrodes should be the same despite the different sizes of anodizing tanks.

(5) Improvement of Rinsing Facility (CP5)

This measure consists of the following 4 measures.

a. Installation of shower system

To prevent contamination of anode beams, a shower system shall be installed at the second rinsing tank after anodizing. This can also eliminate electrolysis interruption. A pair of rinsing shower pipes should be installed on the second rinsing tank after anodizing. While in the rinsing tank a valve is opened automatically and rinsing water is sprayed to rinse the anode beams.

b. Installation of over-flow gutters beside rinsing tanks

Over-flow gutters are installed for all the eight rinsing tanks. By installing water supply pipes at the bottom of the rinsing tanks and overflow gutters at the top of the rinsing tanks, water will flow from the bottom to the surface in the tanks.

c. Installation of water supply piping for rinsing tanks

A water-supply pipe is led into the bottom of each rinsing tank. Accordingly water will flow from the bottom to the surface. Pipes are installed in all the eight rinsing tanks.

d. Installation of air agitation pipes in rinsing tanks

To increase rinsing efficiency, air agitation piping at the bottom is installed for all the rinsing tanks.

(6) Introduction of Counter-current System (CP6)

The water used in the third (final) rinsing after anodizing can be sent to the second rinsing tank after anodizing. Recycling of used rinsing water into other rinsing tanks will reduce water consumption.

9.4.2 Outline of CP Measures

Six CP measures were introduced and the outline of each measure is as follows:

(1) Rearrangement of Wiring between Rectifiers and Tanks (CP1)

Refer to attached Figure 9-4. This CP measure includes the following:

a. Rearrangement and addition of copper bus bars, and
b. Cable connections between bus bars and anode stands or cathode beams.
   Copper bus bars are connected to the output terminal of the rectifier and they are connected to anode stands or cathode beams, and electricity should be supplied to both sides of each anodizing tank.

(2) Installation of Newly Designed Anode Stands (CP2)

Refer to attached Figure 9-5. This CP measure includes the following:

a. Installation of anode stands, and
   4 anode stands are arranged on both sides of an anodizing a tank -- a total of 12 anode stands are installed for three anodizing tanks.

(3) Replacement of anode beam sets (CP3)

Refer to Figure 9-6. This CP measure includes the following:

a. Renewal of anode beams,
   Number of anode beam sets: 18.
   - Each anode beam is as follows.
     a=6 inch, b=4 inch, c=0.4 inch, Length=26 feet
   - Contact plates are placed near both ends; attached by welding or by nuts and bolts.
   - Contact plates are also placed in bracket on anode stands.
b. Renewing splines:
   - The maximum electric current in a spline is 1500 A.
c. Renewing spline settings:
   - Spline settings are designed so that splines can be set or released easily.

(4) Refreshment of Cathodes (CP4)

Refer to attached Figure 9-7. This CP measure includes the following:

a. Renewing cathode beams:

- Number of cathode beams for 3 anodizing tanks is 9 in total.
- Cathode beam dimension are same as those of anode beams.

b. Renewing aluminum cathode:
   - To enlarge the surface area, aluminum sections are saw-patterned.
   - Surface area of cathode plate is 0.7-1.5 times that of raw materials to be anodized.

c. Preparing cathode covers made of plastics:
   - Cathode plates are designed so that they can protect cathode beams from corrosion by chemicals and water drops.

(5) Improvement of Rinsing Facilities (CP5)

Refer to attached Figures 9-8, 9-9 and 9-10. This CP measure includes the following:

a. Installation of over-flow gutters in rinsing tanks:
   - Volume of discharged water from a tank is 5-40 litres/minute.
   - Number of rinsing tanks is 9 and an over-flow gutter should be installed for each rinsing tank.

b. Installation of pipes for air agitation in rinsing tanks:
   - Air agitation pipes should be installed just under anode beams.
   - Number of rinsing tanks is 9 and an air agitation pipe should be installed for each rinsing tank.

c. Installation of a drainage pipe for discharging water:
   - Volume of discharged water from rinsing tank is 5-40 litres/minute.
   - There are 5 alkaline rinsing tanks and 4 acidic rinsing tanks.

d. Installation of a water shower on a rinsing tank:
   - A water shower should be installed for No. 15 rinsing tank.
   - Showering water volume is 10-40 litres/minute.
   - Showering water is supplied when an anode beam is in the tank, therefore a sensor should be equipped that can switch on and off a magnetic valve on the water supply pipe.

(6) Introduction of Counter-current System (CP6)

Refer to attached Figure 9-11. This CP measure includes the following:

a. Installation of a sub-tank,

b. Installation of a pump:
   - The water volume is 5-40 litres/minute.

c. Installation of a level sensor.

(7) Expected Effects

Annual savings by CP introduction was estimated at RM96,000 and product quality improvement was also expected as described earlier. With regards to environmental protection, it was expected that wastewater discharge be reduced by 15%.

(8) Estimated Investment Cost

Investment cost required for CP introduction was roughly estimated at RM265,000. However, it was found that raw materials for anode beams were imported and they would cost higher than estimated.

(9) Schedule

Refer to CHAPTER 7 “Implementation Schedule”.

For Perusahaan TGB Sdn. Bhd., the completion of construction work was scheduled at the end of November 2001, and the final test operation was performed at the end of December 2001 on schedule.

9.5 CP Investment

The total investment for CP introduction was RM400,000 as shown in Table 9-1.

Table 9-1 Investment for CP Measures

No.	Item	Quantity	Amount (RM)
CP1	Rearrangement of wiring between rectifiers and tanks	1 set	94,100
CP2	Installation of newly designed anode stands	1 set	14,500
CP3	Replacement of anode beam sets	18 sets	151,000
CP4	Refreshment of cathodes	1 set	123,300
CP5	Improvement of rinsing facilities	1 set	13,100
CP6	Introduction of counter-current system	1 set	4,000
	Total		400,000

In these investments, costs for design, equipment & machinery, construction materials, transportation, construction, operation manuals, commissioning & training, and spare parts are included.

9.6 Performance Confirmation

The performance of CP equipment introduced was confirmed as described below. It was not necessary to take water samples for analysis after CP introduction.

(1) Reduction of Anodizing Voltage (CP1,CP2,CP3,CP4)

Output voltage at the rectifier and also the voltage inside the anodizing tank were measured before and after the introduction of CP equipment to the current paths. Details of the voltage measurement method are shown in Figure 9-2. The dotted lines are the current paths added through CP measures. V1 and V2 are voltage meters. V1 shows the output voltage, while V2 shows voltage inside the tank. Before CP introduction, the voltages of V1 and V2 were around 17 volts. This value was too high for this plant. However, the voltage difference between these two points was very small. From this measurement, it was concluded that a considerable resistance existed in the anode beam sets and in the contact point between anode stands and anode beams. After CP introduction, the both voltages were around 11 volts. This meant that electricity consumption for anodizing was reduced by 35%.

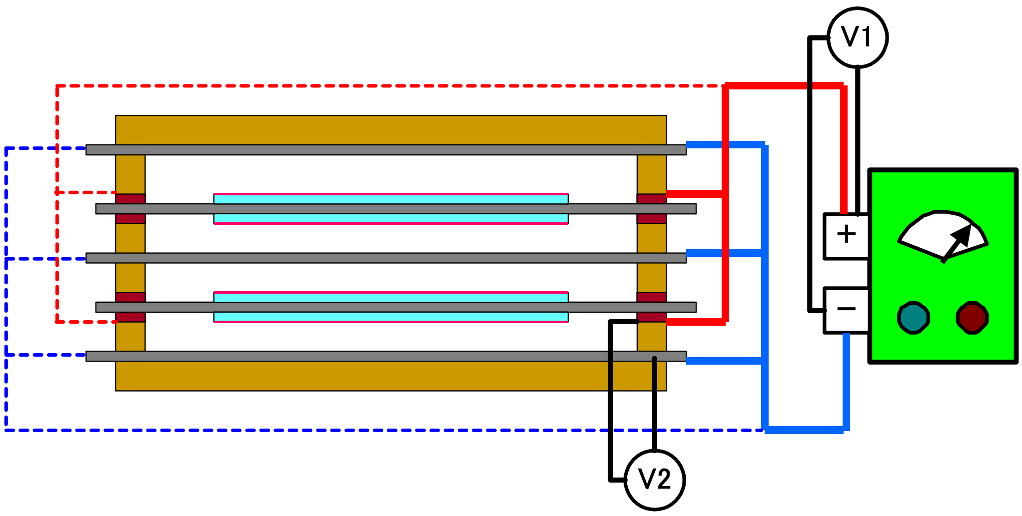

Figure 9-2 Anodizing Voltage Measurement Method

(2) Film Thickness Distribution (CP1,CP2,CP3,CP4)

Anodic oxide film thickness on the aluminum sections was measured by an eddy current type thickness meter made by Fisher Corp. The film thickness was measured at three points for aluminum section of the product. Figure 9-1 shows the film thickness distribution before CP introduction and Figure 9-3 shows the film thickness distribution after CP introduction. Apparently the thickness dispersion in one section is significantly reduced by CP introduction. Assuming that the film thickness difference in a section reduces from 35% to 10% of maximum thickness, electricity required for anodizing electrolysis also reduces by 18.5%.

Through the above calculation, it is confirmed that anodizing time can be reduced by 18.5%, where productivity also increased by 18.5%. Moreover by increasing the current density and immediate electrolysis startup, productivity can be increased by about 20 %.

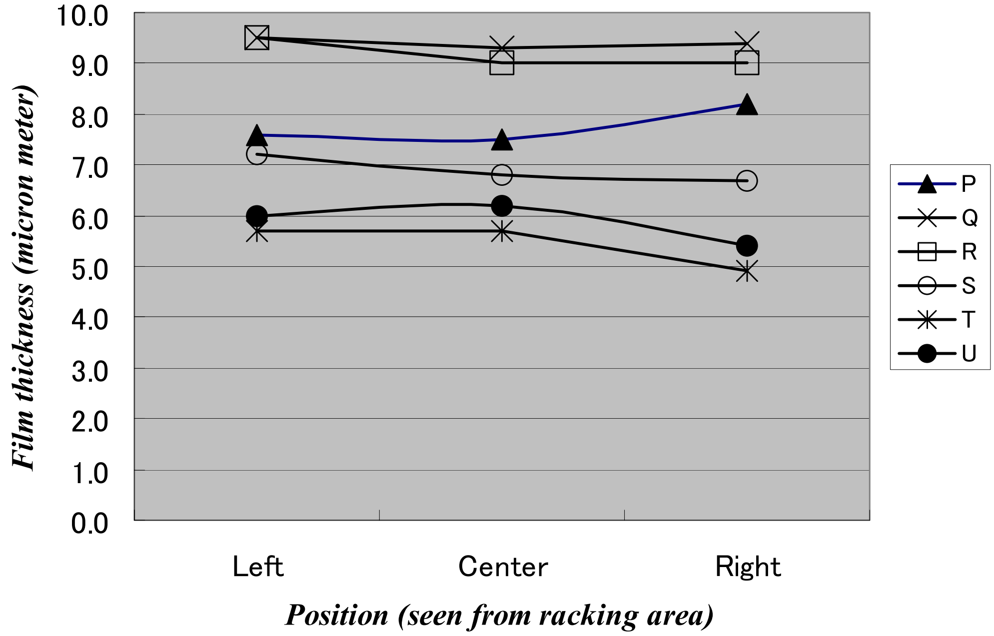

Figure 9-3 Anodic Film Thickness Deviation after CP Introduction

9.7 Reduction of Production Cost and Increased Running Cost

From performance confirmation data, reduction of production cost was confirmed as follows:

(1)	Reduced electricity consumption	RM105,600/year
(2)	Reduced city water consumption	RM6,600/year
(3)	Increased productivity	RM174,000/year
(4)	Decreased labour cost	RM28,000/year
	Total	**RM314,200/year**

Outline of reduction of production cost is as follows:

(1) Reduction of Electricity Consumption

It was impossible to break down electricity consumption into each CP measure; therefore, total electric consumption data in the whole plant was used to calculate the efficiency through the introduction of CP equipment. Production volume per rack was calculated from the operation records of the plant. Actual data from June to October in

2001 was used for the calculation before CP introduction, and data in January in 2002 was used for the calculation after CP introduction. From these data, it was found that electricity consumption was reduced by 19.3% through CP introduction.
The reduced sum per year for electricity consumption was calculated from the following formula:

Electricity consumption sum
= average electricity per rack x unit price (RM0.258/kWh)
x rack number per year x electricity reduction rate (19.3%)

Using an estimated number of racks per year, the electricity consumption sum was calculated as **RM105,600** per year.

(2) Reduction of City Water Consumption

It was also impossible to break down city water consumption into each CP measure; however, it was assumed that most water was used in the rinsing process. Consequently city water consumption for the whole plant per day was used for the evaluation. The first factory audit was carried out in December 2000, when the plant was using 60 tons of city water per day. Afterwards, the factory reduced city water consumption from 60 tons to 24.8 tons per day through their own plant improvements. Additionally, through CP introduction, city water consumption was further reduced from 24.8 tons to 13 tons per day. Therefore, the reduced sum per year for city water consumption was calculated from the following formula:

City water consumption sum
= Unit price of city water (RM1.91/t) x reduced city water consumption per day
x operation days per year (294 days/year)

Through this calculation, city water consumption through the introduction of CP was calculated as **RM6,600** per year.

(3) Increased Productivity

By renewing and adding electricity paths such as bus bars and wires, maximising electric current from each rectifier became possible, and anodizing time was reduced. Consequently production volume was increased by 20%. Sales in 2001 was RM1,740,000; therefore, sales in 2002 is expected to be RM2,088,000.
By analysing production cost, the variable cost is about 50% of sales. Using this data, the increased profit per year was calculated in the following formula:

Increased profit
= sales in 2001 x increased production volume (20%) x variable cost rate (50%)

Increased profit through CP introduction was calculated to be **RM174,000** per year.

(4) Decreased Labour Cost

In Malaysia, the quality of anodized aluminum products is judged by good surface appearance, and rarely is film thickness checked strictly. Therefore the reject rate of products is very small, and rejects are caused by abnormal conditions in the plant. Reduction of rejects is rarely calculated. The control of film thickness became easier through the introduction of CP, and improvement in product quality and increase in customer confidence in the company can be expected.

By reducing anodizing time, productivity increased and working hours decreased by two hours per day.

The decrease in labour cost per year was calculated using the following formula:

Decreased labour cost
= reduced working hour (2 hours/day) x unit wages x number of workers
x operation days per year (294 days/year)

Decreased labour cost through CP introduction was calculated as **RM28,000** per year.

9.8 Financial Analysis

This factory was built in 20 years ago; therefore the equipment was old and inefficient, especially in electric facilities and rinsing system.

The factory introduced CP1, CP2, CP3 and CP4 in order to reduce the consumption of electricity by renewing or improving electric conductive materials, and to increase the productivity through improved electric efficiency. CP5 and CP6 were introduced to reduce the consumption of city water and the discharge of wastewater through improvement of rinsing facilities, and through reuse of rinse water respectively. Actual investment, cost saving and increased cost of each CP measure is shown in Table 9-2 and the calculated POT and IRR are shown in Table 9-3. The calculation for POT and IRR in total investment shown in Table 9-4 was made by using the data in Table 9-2 using methodology explained in 5.4.3.

Table 9-2 Investment and Cost Saving Data

		CP1	CP2	CP3	CP4	CP5	CP6	Total
Investment	RM	94,000	14,000	151,000	123,000	13,100	4,000	400,000
Cost saving	RM/y	92,000	92,000	77,000	46,000	3,600	600	312,000
Increased cost	RM/y	0	0	0	0	0	0	0

Table 9-3 POT and IRR for CP Measures

		CP1	CP2	CP3	CP4	CP5	CP6	Total
POT	year	1.4	0.2	2.7	3.6	3.7	2.7	1.7
IRR	%/y							60

Table 9-4 Calculation for POT and IRR in Total Investment

1,000RM

Year	0	1	2	3	4	5	6	7	8	9	10
Investment	400										
Cost saving		312	312	312	312	312	312	312	312	312	312
Increased cost		0	0	0	0	0	0	0	0	0	0
Interest		24	10	0	0	0	0	0	0	0	0
Income tax		53	81	84	84	84	84	84	84	84	84
Net cash flow	-400	235	221	228	228	228	228	228	228	228	228
Depreciation		112	32	32	32	32	32	32	32	32	32
Loan balance	400	165	0	0	0	0	0	0	0	0	0

The result of CP introduction was analysed financially as follows.

CP1 has a very good profitability with POT of 1.4 years, because the reduction of electricity consumption and the increase of productivity by CP1 are very large. Furthermore, CP1 does not require additional cost through the introduction of equipment because the equipment was installed to replace old facilities.

POT of CP2 is 0.2 years; so the profitability is also very good. It achieved the same amount of cost savings as CP1 though the investment is much smaller than that of CP1.

CP3 is the largest investment but its cost saving is smaller than CP1 or CP2 because of less efficiency of the electricity reduction and productivity increase. Therefore POT is 2.7 years and is longer than CP1, but profitability is judged to be good. The profitability of CP4 is sufficient although the investment is the second largest but the cost saving is smaller than CP1, CP2 or CP3. POT is 3.6 years.

As there were many facilities that could be improved, especially electric facilities, CP measures were very efficient and POT of the total of CP1, CP2, CP3 and CP4 is 1.4 years.

It is considered that these measures will be successfully applicable to other factories in situations similar to the model factory.

Although the improvement of the rinsing system is a less profitable, POT of CP5 is 3.7 years and POT of CP6 is 2.7 years; so profitability of these investments is sufficient. These rinsing system improvements were planned about 1.5 years before, when city water consumption was much greater. As the model factory had reduced city water consumption through their own efforts prior to installation, the profitability of installed CP measures is lower than the plan.

It should be added that CP5 is effective to improve the product quality, and complaints from the customers were reduced. The total investment in the model factory has a very good profitability where POT is 1.7 years and IRR is 60 %. This means that any factory in the same situation as the model factory can recover the investment within 2 years if the factory borrows all required money from a bank. Finally any one of the CP measures can be recommended on its own to other factories as each measure has good profitability.

9.9 CP Benefit

It was confirmed that the model factory could reap the following benefits through the six CP measures implemented.

(1) Through the reduction of electricity and city water consumption and labour cost, the model factory could decrease production cost by RM314,200 per year.

(2) From the financial analysis result, it is said that this project is a good investment. CP measures were very efficient in improving electric facilities. On the other hand, the improvement of the rinsing system is a less profitable because the model factory had reduced city water consumption through efforts prior to CP introduction.

(3) Through the introduction of CP1, CP2, CP3, CP4 and CP5, the following operational benefits were confirmed by the model factory:

a. Full capacity current of rectifiers could be realised,
b. Temperature of copper bus bars dropped,
c. Anodizing operation could be started-up immediately,
d. Rinsing water became clear,
e. Soda stain on anode beams disappeared, and
f. Wastewater treatment control became easier.

(4) In addition to expected benefits, the model factory reported that there was a total uplift in worker morale at the factory. In Japan, CP movement is a part of "Kaizen". It is a QC activity to improve one's own plant and workers should participate in the activities. It is very important that workers in the plant have interests in the CP activities. The improved plant makes workers proud of their jobs and promotes participation in the CP activities.

9.10 Recommendations

Recommendations for the metal finishing and electroplating sub-sector is described in Chapter 8.

Attached Drawings

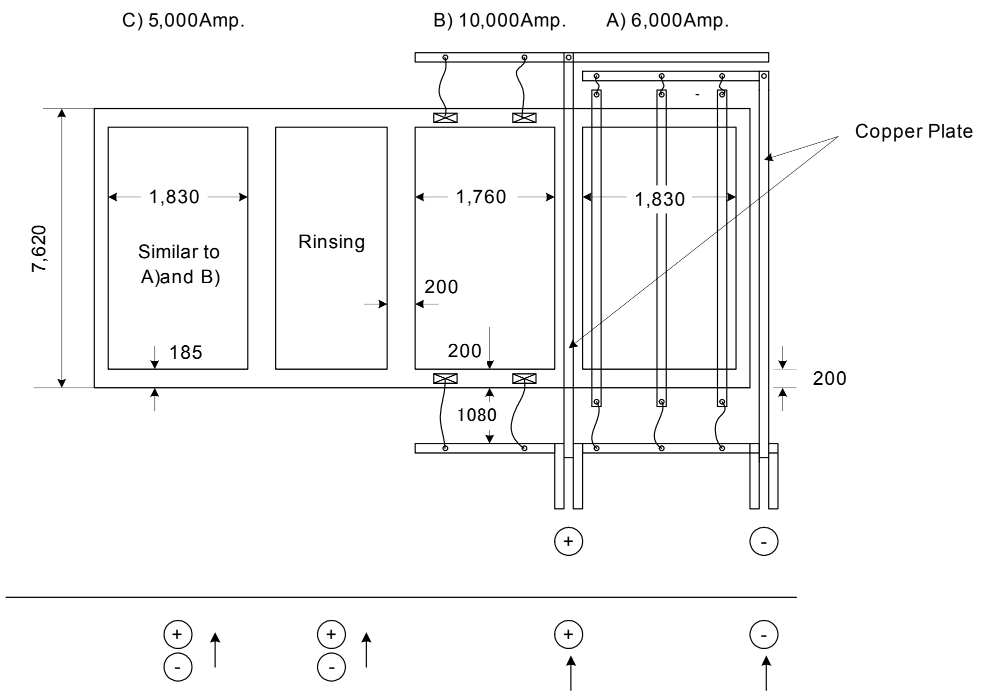

Figure 9-4 Wiring System between Rectifiers and Tanks

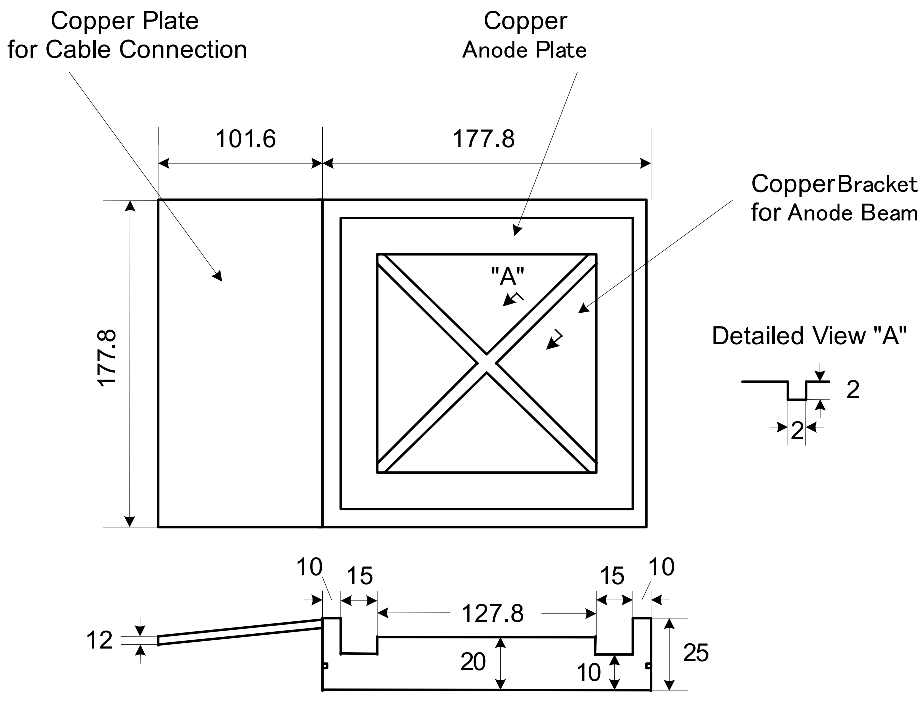

Figure 9-5 Newly Designed Anode Stands

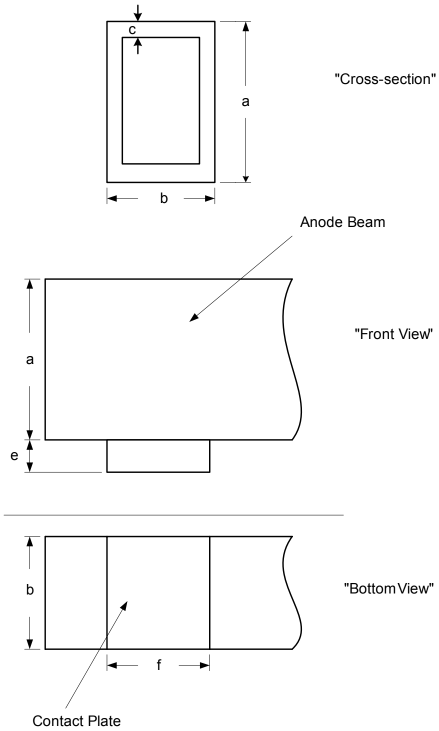

Figure 9-6 Anode Beam Set

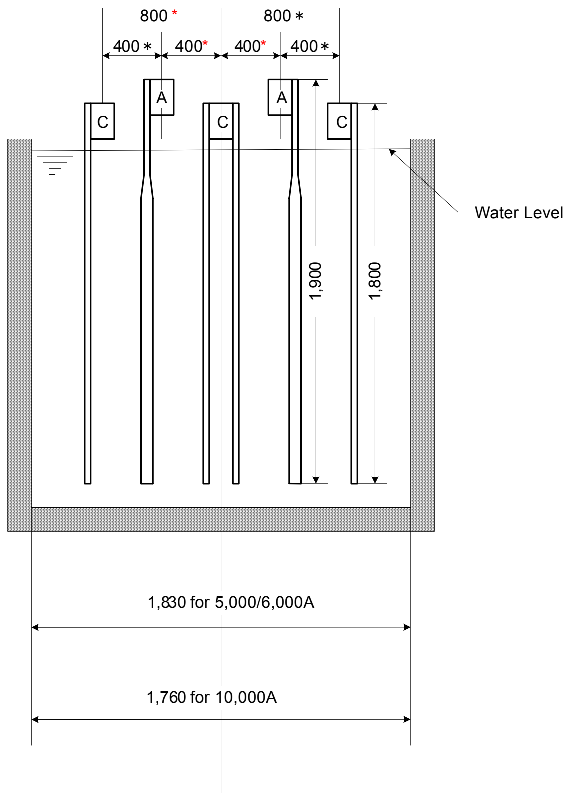

Figure 9-7 Refreshed Cathodes

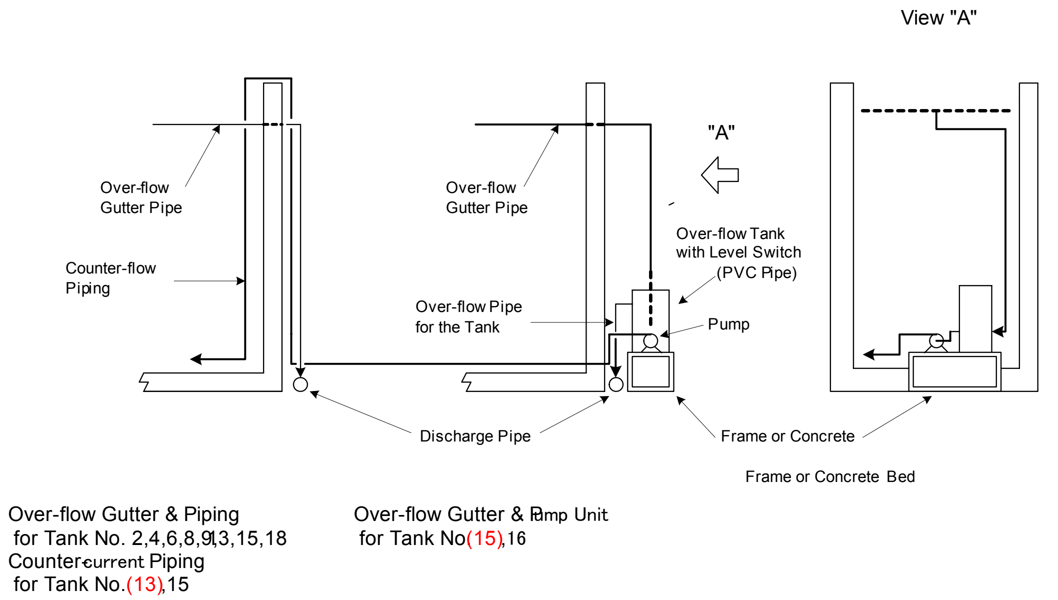

Figure 9-8 Improvement of Rinsing Facility (Over-flow Piping)

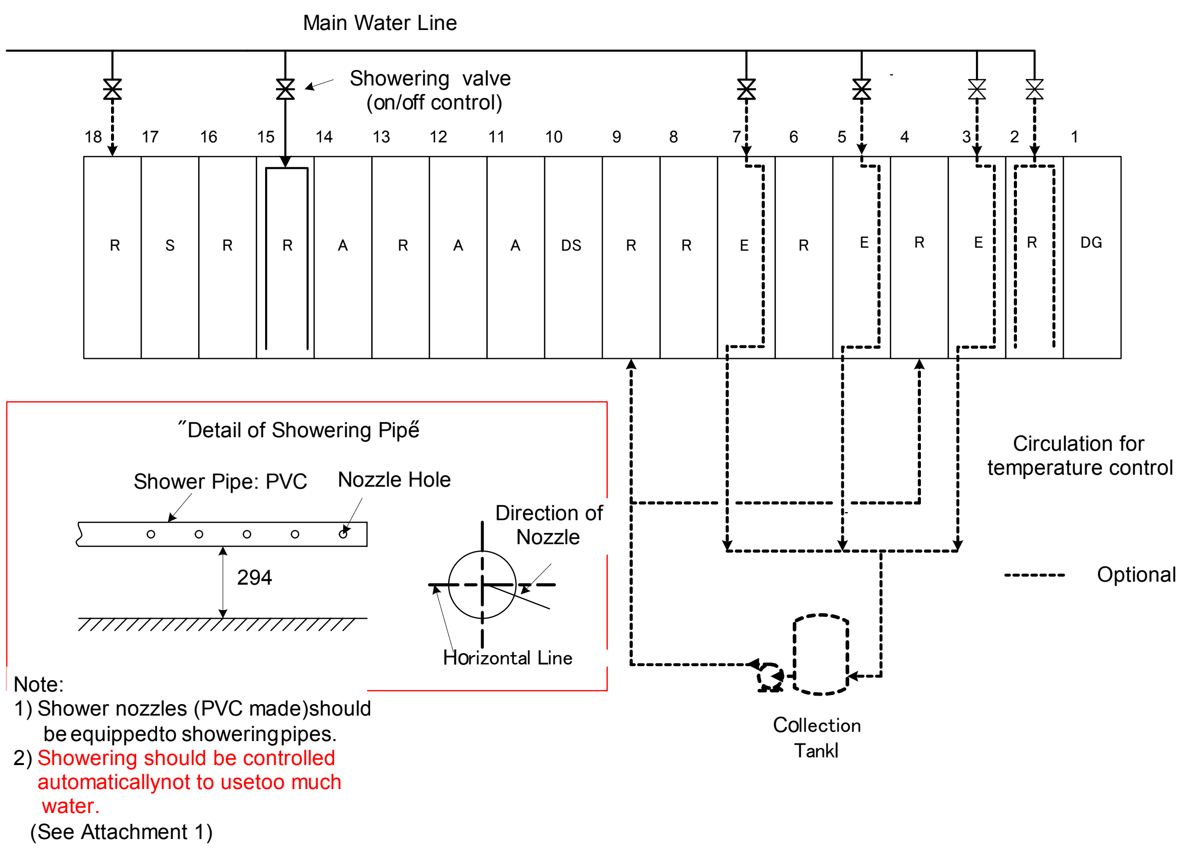

Figure 9-9 Improvement of Rinsing Facility (Showering System)

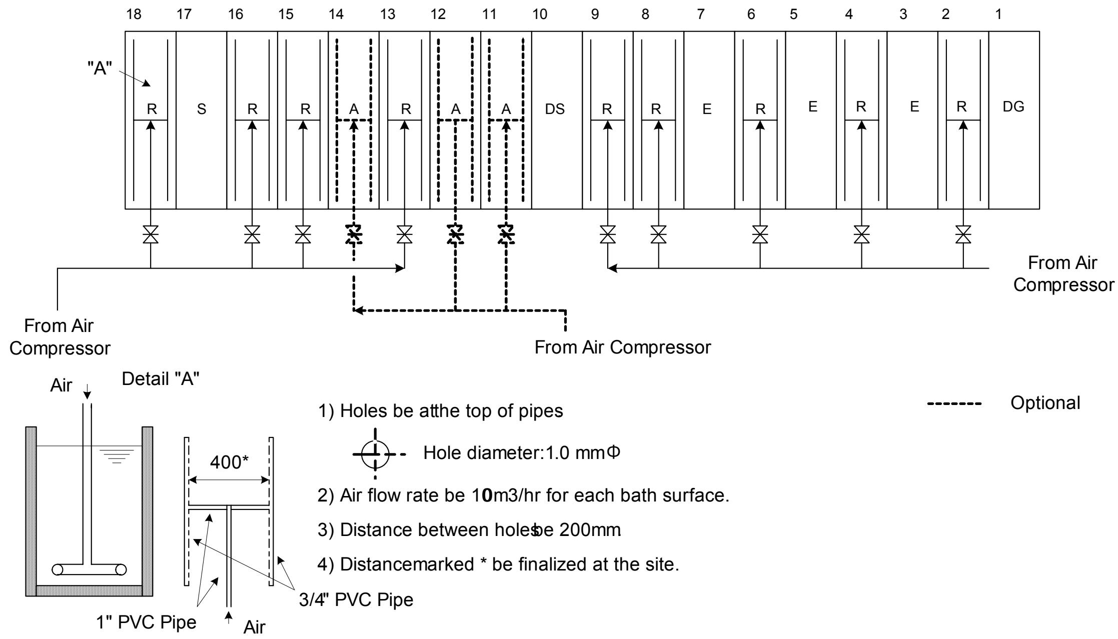

Figure 9-10 Improvement of Rinsing Facility (Air Showering System)

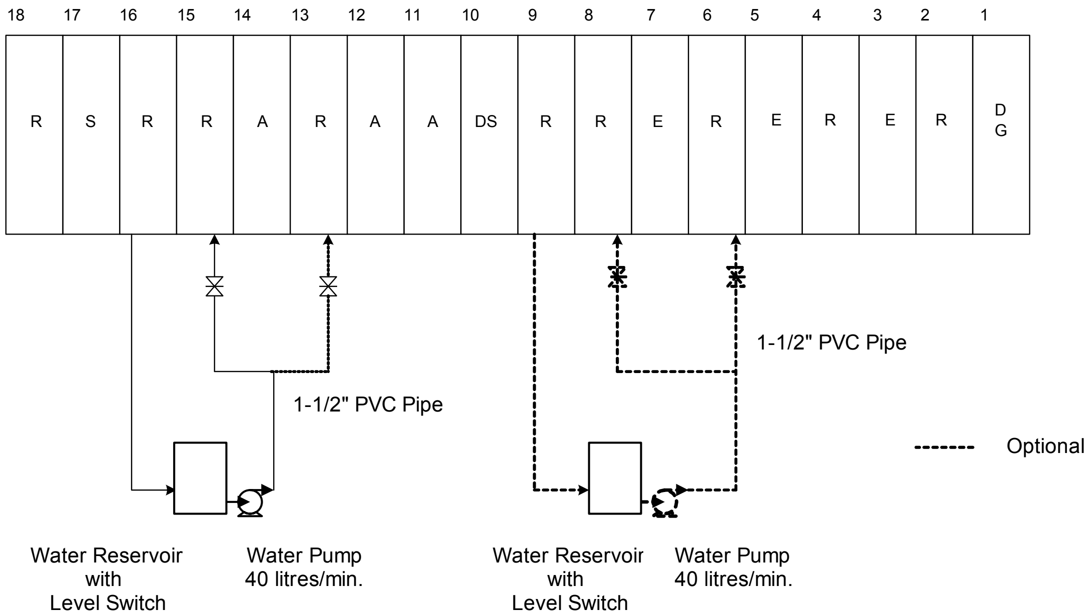

Figure 9-11 Counter Flow System

Demonstration Project for Cleaner Production

in Aluminum Anodizing Sub-sector

Model Factory: Perusahaan TGB Sdn. Bhd.

Production Line

Anode Stand and Anode Beam

Cathode Beam

Air Agitation and Overflow Gutter

Showering for Anode Beam

CHAPTER 10

DEMONSTRATION PROJECT IN THE FOOD AND BEVERAGE SUB-SECTOR

CHAPTER 10 DEMONSTRATION PROJECT IN THE FOOD AND BEVERAGE SUB-SECTOR

Model Factory: Winner Food Industries Sdn. Bhd.

10.1 Factory Survey Results (General)

10.1.1 Surveyed Factories and their Outline

During the first field survey, the following five representative companies were audited:

(1) Winner Food Industries Sdn. Bhd.,
(2) Awra Food Processing Sdn. Bhd.,
(3) Cocoaland Industry Sdn. Bhd.,
(4) Universal Nutri-Beverage Sdn. Bhd., and
(5) Vit Makanan (KL) Sdn. Bhd.

Each factory produces different products under different situations and an outline of each factory follows. The present status and CP options for each factory are described in the Attachment.

(1) Winner Food Industries Sdn. Bhd.

The factory produces wet noodles in a small plant, and it is located in old industrial area where small factories are scattered here and there. This factory is using a comparatively large amount of water for cooling noodles and washing rice (one of the raw materials) as once-through operation.

(2) Awra Food Processing Sdn. Bhd.

The factory produces burgers and nuggets with a new plant, which was built in August 2000. The employees are young and active in clean, white uniforms. The company's director possesses a doctorate in a food industry field and the whole atmosphere in the factory is good. The major source for energy consumption is a freezing system, and it is well systematized. The plant has sufficient room for future expansion. Though the discharge of the waste water is not high, DOE pointed out its quality and requested immediate improvement. The company has a consultant under contact for wastewater treatment procedures.

(3) Cocoaland Industry Sdn. Bhd.

The factory produces candies snacks and wafers in comparatively large scaled plant located in new industrial area. The candy plant is rather complicated like a chemical process. Their organisation is well organised with department of QA/R&D and a department of maintenance.

(4) Universal Nutri-Beverage Sdn. Bhd.

The factory produces fruit juice cordials (concentrated juice) by melting sugar in hot water and adding flavors and ingredients. The production process requires only mixing and bottling and is not difficult. The factory is located in the suburbs of Shah Alam. Management attention to energy saving seems a little poor.

(5) Vit Makanan (KL) Sdn. Bhd.

The factory produces instant (fried) noodles and dried noodles in Rawang Industrial Park. This factory is new and equipped with the latest machines. The factory is using a lot of steam in the noodle steamer and for heating edible oil for fryers. Most of the used steam is recovered as boiler feed water. There are few problems in this factory, so suitable CP measures are difficult to find.

10.1.2 Observation of Pollution Control Condition

Each of the five factories audited produces different products, and therefore various types of wastewater and exhaust gas are discharged and emitted. Most factories audited operate their production equipment batch-wise; therefore, the amount of wastewater and contaminants are neither continuous nor constant. None of the five factories is provided with water treatment facility. However, due to the exception rule for water pollution control, which does not regulate wastewater under 60 m^3/day or 6 kg BOD/day, three of these factories are considered exempt from regulation. As for boilers, four factories are using diesel oil and the other is using sawdust as fuel. Since the boilers have capacity of a maximum of 5.6 t/h and emit only a small amount of exhaust gas, which is estimated at 6,000 m^3/h, they are also exempt from regulation.

10.1.3 Waste Disposal, Treatment and Recycling

Most wastes generated from packing materials for products, raw materials, and sub materials are small in amount and not harmful. The wastes are re-used in the factories, returned to the original suppliers, or disposed in the factories. In cases, where garbage is mixed into discharged wastewater, the problem is not serious at the moment. But in the future, with more stringent regulations, more detailed study will be required.

10.1.4 Measures for Productivity Improvement

Two of the five factories audited are equipped with new machines while the other three possess rather old machines. The new factories have the latest machines and processes, which are effectively systematized, for example:

a. The load control system of refrigerator compressors, the system for load balance on the freezing unit, and allocation of cooled warehouses in order of temperature (in Awra Food Processing Sdn. Bhd.), and
b. Recovery of steam condensate from heat exchangers and noodle fryer (in Vit Makanan (KL) Sdn. Bhd.).

In the three old factories, efforts for operational improvement were observed, for example**:**

a. Steam heating for sugar dissolving based on the specified ratio of sugar and water (in Universal NutriBevarage Sdn Bhd.), and
b. Recovery of steam condensate from jackets of hot vessels in the sugar dissolving unit (in Cocoaland Industry Sdn. Bhd.).

In general, however, machine operational techniques are bound by conventional rules without consideration for new methods or ideas. From this point of view, detailed study for meticulous control of operations should be emphasised.

10.1.5 CP Options in the Food and Beverage Sub-sector

Measures for improvement by Cleaner Production (CP) are classified into three categories as follows:

(1) Improvement of production process
(2) Energy and utility saving
  a. Control of boiler burner combustion
  b. Recovery of steam condensate
  c. Electric power saving by the improvement of power factor
  d. Prevention of heat loss around boiler and steam systems including heat recovery from exhaust gas
(3) Prevention of public pollution
  a. Reduction of water consumption by process improvement

Targeted field for CP options are shown in Table 10-1.

Table 10-1 Targeted Field for CP Options

Company / Applicable CP Option	A	B	C	D	E
1. Improvement of production process	x		x	x	
2. Energy and utility saving					
a. Steam			x	x	x
b. Fuel			x		x
c. Electricity		x			
d. Water	x		x	x	
3. Waste					
a. Wastewater	x	x	x	x	
b. Exhaust gas					

Note-1: A、B、C etc. represent the following company.

A: Winner Food Industries Sdn. Bhd. D: Universal Nutri-Beverage Sdn. Bhd.
B: Awara Food Processing Sdn. Bhd. E: Vit Makanan (KL) Sdn. Bhd.
C: Cocoaland Industries Sdn. Bhd.

Note-2: "x" means applicable CP options.

10.1.6 Selection of Model factory

Refer to CHAPTER 5, section 5.2 "Selection of Model Factories".
Winner Food Industries Sdn. Bhd. was selected as a model factory in the food and beverage sub-sector.

10.2 Status of the Selected Model Factory before CP Introduction (Winner Food Industries Sdn. Bhd.)

(1) Outline of the Factory

The company has 25 employees, occupies an area of 1800 m^2, was established in 1986, began operation in 1996 with a capital of RM0.35 million, and its monthly production of noodles is 650 tons. The factory is rather small, but produces a comparatively large amount of noodles. Major energy consumption is by a boiler for noodle steaming, and its fuel is sawdust which is obtained free of charge. Also, water is free of charge due to the use of well water (underground water), which is used in large volume. Therefore, with a view for CP, reduction in the use of well water and in wastewater generated can be study themes.

(2) Observation of Pollution Control Condition

Wastewater and exhaust gas are the main subjects for pollution control. Most wastewater comes from drainage of cooling water used for boiled noodles and from a rice washing process. It seems that the wastewater exceeds the regulated limitations on quantity and contaminant which is discharged to a nearby stream without any treatment and joined together with other housing drainage. The exhaust gas from the boiler is generated by combusting 3 t/day of sawdust for 2 t/h steam generation, though actual operation rate seems around 50%. Operation time is approximately 18-20 hours per day. The amount of exhaust gas is estimated at 2,000 m^3/h based on sawdust combustion and is considered exempt of regulation because it is low.

(3) Waste Disposal, Treatment and Recycling

The solid waste can be categorised into two items as follows:

a. Waste from packing materials for products, raw materials and sub materials; the amount is low and is handled through reuse, return to suppliers or incineration, and
b. Pollutant from waste of main production, which is discharged to a stream along with wastewater.

(4) Measures for Productivity Improvement

Almost all the equipment and machines are of an old and conventional type; for example, operational technology is Japanese technology introduced many years ago. Major utilities such as well water and fuel sawdust are currently free of charge. Well water is used without any treatment, and is regarded safe because the final preparation of products undergoes a boiled water process. For productivity improvement, a considerable reduction of fuel cost was achieved by changing fuel from diesel oil to sawdust; previously, noodles were boiled and steamed by burners attached to each machine, but now steam from the boiler is instead used as heat source.

10.3 CP Options in the Model Factory

Present problematic issues in the factory that need CP measures are summarised as follows:

(1) Reduction of water consumption in rice washing unit,
(2) Effective utilisation of noodle cooling water, and
(3) Improvement of well water quality.

(1) Reduction of Water Consumption in Rice Washing Unit

The existing rice washing unit utilises approximately 10-13 m^3 of water for washing 1,400 kg of rice per batch. Generally, a modern unit utilises four or five times as much water as rice. Therefore, water for rice washing in the factory can be reduced to 5-6 m^3 by replacing the existing system with a new unit.

(2) Effective Utilisation of Noodle Cooling Water

The current wastewater is about 130 m^3/day for 8-9 tons of raw material flour, namely 14-15 litre of water per 1 kg flour, which is less than the average in Japan: 30-50 litre. Therefore, it seems difficult to reduce the water consumption in the factory. However, it is recommended that trials be conducted for more effective utilisation of water by reforming water sprays and the cooling bath.

(3) Improvement of Well Water Quality

Well water is being used primarily for cooling noodles and city water is used for boiler feed water (BFW). If instead of city water, well water was used as process water after sanitary treatment and for boiler feed water after softening, utilisation of water will become more practical in terms of cost savings. This subject will require more detailed study.

The following measures were also considered as CP measures for the model factory. However, they were not taken up this time because they needed more detailed study from technical and economical viewpoints.

a. Rice noodle line:
   (i) Waterless
   This system dose not use water at all and, of course, discharges no wastewater, though rice bran and other solid waste be generated. However, at the moment, this technology is not open to the public.

b. Yellow noodle line:
   (i) Full covered unit
   (ii) Water chilling unit
   From the view point of food hygiene and quality (taste), these systems are used in Japan.

10.4 CP Measures

10.4.1 Selected CP Measures

The objectives of CP introduction are to reduce both water consumption and wastewater discharge in a noodle producing factory through improvement of water utilisation, and to achieve better quality well water for process use. For these purposes, the following CP measures were selected:

(1) Reform of rice washing system,
(2) Reform of noodle cooling system, and
(3) Improvement of well water.

(1) Reform of Rice Washing System (CP1)

Rice washing water consumption can be reduced by changing the washing system. Water required for rice washing is 4-5 times the weight of rice. Present usage of water is about 8-10 times. The reason for this is that the washing system only utilises water in a flow and recycle action, so the physical action is not strong enough to wash the rice properly. If a grain washing machine unit is used,

a. Separation of dust by floating and precipitation,
b. Cleansing by mixing, and
c. Polishing

can be done in a single unit. The water consumption can be reduced to 4 times the weight of rice, and total contaminant amount will not change. In the next stage, final water treatment may be required.

(2) Reform of Noodle Cooling System (CP2)

By introducing this CP measure, the consumption of noodle cooling water can be reduced. Yellow noodles are cooled by large amounts of water during operation time (12-16 h/day) and discharged directly out of the factory.

The cooling system is as follows:

Water spray → Pass under water bath → Water spray again → Air cooling → Natural cooling

The water used here is difficult to re-use or recycle because of its high temperature and contamination. Zero use of water is also impossible, because the functions of water are important for:

a. Quality control by quenching,
b. Cleaning, and
c. Stick prevention (starch removal).

Therefore, further study must be carried out on methods for reduction of water consumption, such as combination of water spray and air cooling, by more effective water spray, etc.

(3) Improvement of Well Water Quality (CP3)

To decrease city water consumption as much as possible, a chlorine dosing unit for sanitary treatment and a water softening unit for boiler feed water could be added to the existing well water system

10.4.2 Outline of CP Measures

(1) Layout

Figure 10-1 shows a plot plan for general layout of equipment related to CP1, CP2 and CP3 introduction, from right to left a new rice washing machine, a noodle cooling unit and a well water treatment unit, respectively.

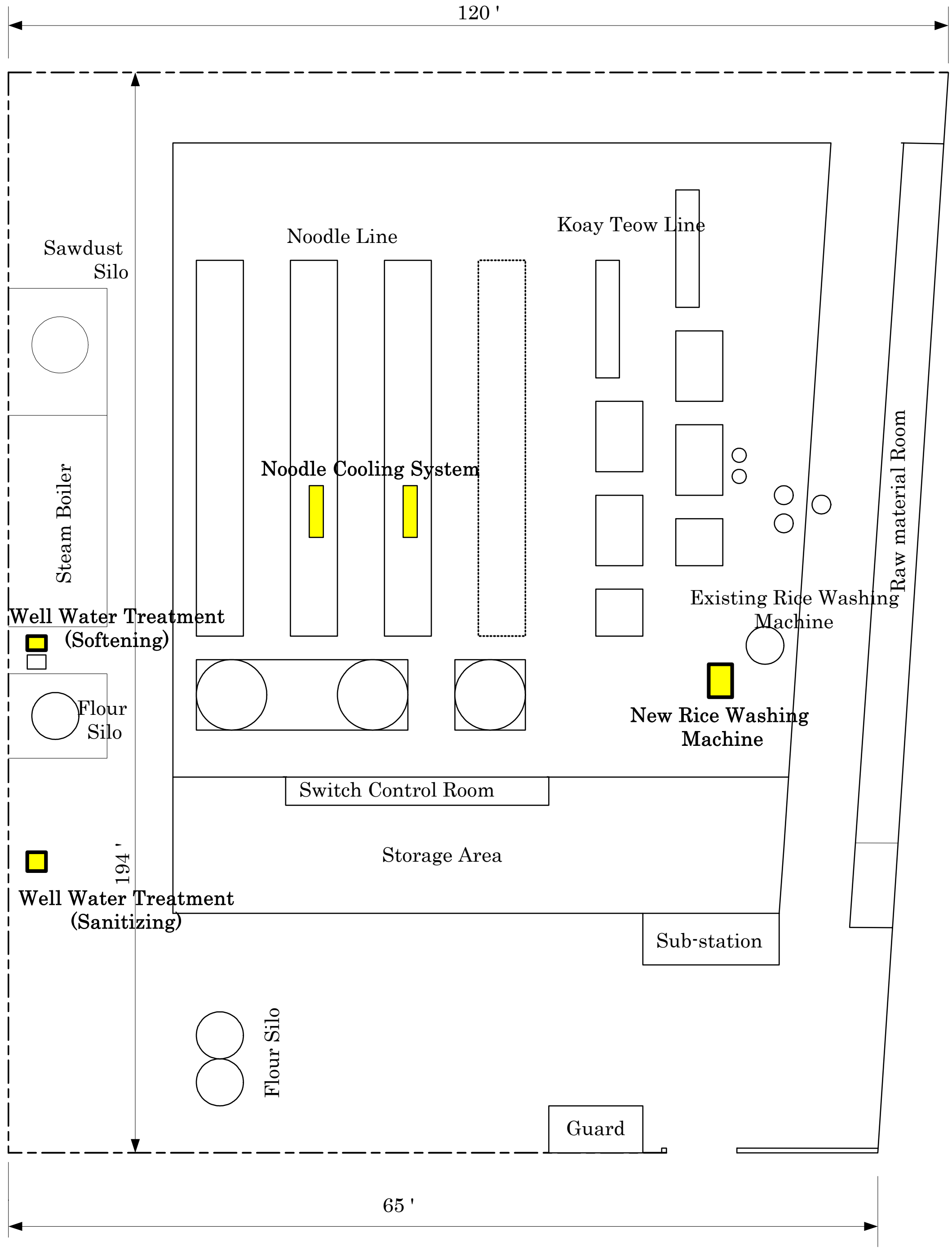

Figure 10-1 General Plot Plan of the Factory

(2) Basic Flow Scheme

Attached drawings, Figures 10-2, 10-3 and 10-4 show the basic flow scheme of a new rice washing machine, a noodle cooling system, and water treatment system, respectively. Each flow scheme is briefly explained below.

a. New rice washing machine (Refer to Figure 10-2.)
The existing hopper and tray for rice washing is used for washed rice storage, and a new machine is to be installed at the front part. Rice is put into the inlet hopper of the machine, rinsed with water in a lower drum equipped with several propellers, polished in an upper rotating drum, and then discharged from the outlet chute. Basically, the machine is designed for continuous operation although the factory's operation is batch-wise; therefore, careful arrangement and planning is required. After sent to the tray, rice is consequently processed by the existing system.

b. Noodle cooling system (Refer to Figure 10-3.)
Fresh water is pressurised by a pump and sprayed onto noodles directly at the front where existing cooling baths are to be modified. Then, warmed water in the baths is recycled by the existing pump and sprayed onto noodles at the rear.

c. Quality improvement of well water (Refer to Figure 10-4.)
A chlorination unit is to be installed to maintain residual chlorine in well water at 0.5 mg/l in order to attain safer utilisation of water for food processing. A softening unit is to be installed in the well water piping in order to use well water for BFW.

(3) Specification for Major Machine and Unit

Table 10-2 shows major machine and units and specification.

Table 10-2 Major Equipment/Units and Specifications

Machine and Units	Specification
1. Rice washing machine	Rice washing: 1.5 - 3 t/h Water consumption: 3 - 4 times of rice Electric power: 1.5 - 2 kW
2. Two noodle cooling units	Fresh water pump: 10 m^3/h, h=15 m Four spray nozzles: 2 m^3/h
3. Well water treatment a. Sanitary treatment b. Softening treatment	Injection of chlorinate chemical into 10 m^3/h water, residue Chlorine 0.5 mg/l Total hardness under 25 mg/l (as $CaCO_3$) 2 t/h BFW, 10 kg/cm^2G boiler

(4) Expected Effects

At present, well water, wastewater and fuel are all obtained or discharged free of charge; therefore, it is difficult to estimate the monetary benefit expected through the installation of new machine and units. Table 10-3 shows the increase and decrease of water for estimation.

Table 10-3 Increase and Decrease of Waters

(Unit: per day)

	Well water (@=RM0.0/m^3)	City water (@=RM1.9/m^3)	Wastewater (@=0.0/m^3)
Rice washing	10 → 5 m^3	3 → 1 m^3	12 → 6 m^3
Noodle cooling	90 → 90 m^3	-	90 → 90 m^3
Well water sanitary treatment	110 → 105 m^3	-	-
Well water Softening	0 → 30 m^3	30 → 0 m^3	1 → 1 m^3

As for cost saving factors, there is reduction of city water by changing BFW from city water to well water. As cost increase factors, there will be fixed costs incurred by investment, increase of chemical consumption and other variable costs.

Taking into account future plans, the estimated construction cost for a wastewater treatment unit can be reduced because it is expected that the amount of wastewater be significantly reduced.

(5) Estimated Investment Cost

The total investment cost was roughly estimated at RM272,000 as follows:

a.	Reform of rice washing system	1 set	RM220,000
b.	Reform of noodle cooling system	1 set	RM35,000
c.	Improvement of well water	1 set	RM17,000
	Total		RM272,000

(6) Estimated Running Cost

Just after the basic design was finished, annual running costs before CP introduction and after CP introduction were projected as shown in Table 10-4.

Table 10-4 Comparison Table of Running Costs (Planned)

(RM/y)

		Before CP		After CP	
Rice washing machine	CW	15 t/day	8,550	6 m^3/day	3,654
Noodle cooling	WW	(incl. below)	-	(incl. below)	-
Well water improve	CW WW	40 m^3/day 120 m^3/day	22,800	- 160 m^3/d	18,490
Total			31,350		22,144

Note CW; City Water WW; Well Water

At the planning stage, reduction of annual running cost was estimated as follows:

RM 31,520 - RM 22,144 = RM 9,206.

(7) Schedule

Refer to CHAPTER 7 "Implementation Schedule".

For Winner Food Industries Sdn. Bhd., the completion of construction work was scheduled at the end of November 2001, and the final test operation was performed at the beginning of December 2001 on schedule.

10.5 CP Investment

The actual total investment cost for the CP introduction RM270,000 as shown in Table 10-5.

Table 10-5 Investment for CP Measures

No.	Item	Quantity	Amount (RM)
CP1	Reform of rice washing system	1 set	166,000
CP2	Reform of noodle cooling system	1 set	15,000
CP3	Improvement of well water	1 set	89,000
Total			270,000

In these investment costs, all cost of design, equipment & machinery, construction material, transportation, construction, operation manual, commissioning & training and spare parts are included.

10.6 Performance Confirmation

Attached tables, Table 10-12, 10-13 and 10-14 show confirmed performance data. Through these data, the following was confirmed.

(1) Rice Washing Machine

The model factory operates the rice washing process once a day for around one hour treating 1.0-1.2 ton rice after CP introduction. Recent operation data shows:

a. Rice washing: 1000 kg, 30-40 min., water 1.2 m^3, and
b. Soaking and 2nd rice: 30 min., water 2.5 m^3.

Therefore, the total water consumption is around 4 m^3.

On the other hand, an operation data before CP introduction was,

a. Rice washing and rinsing: 1000 kg, 60 min., water 13-15 m^3

From these data, it was found that both a reduction of laborious work time and a decrease of water consumption were attained. Furthermore, potential for a higher production rate was confirmed.

Rice washing machines (or as grain washing machine) can be useful to industries which use rice or grains in the production process, because of its water efficiency, compactness and operability. Example industries include:

a. Noodle, vermicelli, pasta industry,
b. Say source, soy bean pasta industry,
c. Rice wine, rice vinegar industry, and
d. Confectionery industry, etc.

(2) Noodle Cooling

The cooling spray in the noodle production serves two functions. One is to strengthen the noodles by shock cooling just after boiling, and the other is to remove the sticky starch coated on the surface by using pressurised spray. For the former, two nozzles of fresh water to spray directly onto the noodles, and for the latter, two existing pressurised nozzles with a recycle water pump are used. The water consumption was almost same or a little lower than the system before CP introduction and temperature dropped by around 5℃. The quality of noodles changed and looked better and the company was waiting for evaluation by consumers. However, continuous trials are required to achieve improvement in quality. In Japan, rather large-scaled chilled water units (below 5℃) are used for noodle cooling.

(3) Well Water Improvement

To switch from the use of city water to well water in the model factory, equipment including units for sanitary treatment, removal of chemical smell, and a softener for BFW is installed. There is some fluctuation in the quality of treated water, although operation condition is almost ideal. Residual chlorine concentration through NaClO dosing is 0.3-0.7 ppm (design value is 0.5 ppm), and under 0.1 ppm after passing through an activated carbon filter. Bacillus count is ND (No Detected), and therefore the treated well water can be good enough for usage in food production. Total hardness is under 1 ppm as $CaCO_3$, which has no problem for BFW use. From now on, for long term operation, the following should be monitored: life of activated carbon, frequency of softener regeneration, refill of softener resin, chemical consumption, fouling of boiler tubes, machine maintenance and so on.

In addition to the comparison of running costs, it was confirmed after constant operation, that there were several discrepancies between planned and actual results as follows:

a. For rice washing machine:
- Water reduction estimated by 1/2 resulted in 2/3, and
- Rice charge time estimated no change resulted in 1/2.

b. For noodle cooling:
- Water consumption slightly reduced by 5-10 %, and
- Noodle quality waiting for judgment by consumers.

c. For well water improvement
- City water reduction estimated by 60-70 % resulted in around 100 %; i.e. no city water used, and
- A rather large amount of iron sludge came out from the bottom of the separator tank through chlorine dosing due to the iron content in well water.

With regard to additional CP measures for the model factory, it is recommended that the following be studied in more detail and then put into practice:

a. Hygienic countermeasure for total process:
   For examples, tight covers on roof tanks and full covered system of production lines are required for better hygienic treatment.
b. Installation of a wastewater treatment unit,
c. Recovery of waste noodles discharged with wastewater and use as animal feed, and
d. Gradual reduction of BFW chemicals.

It will be effective for the factory to have a technical adviser, several working days in a week, because there are other possibilities for technical improvements and introduction of ISO 9001 and/or HACCP is expected. Additionally, as the following difficulties may arise, advance study should be undertaken and countermeasures prepared.

a. Severe control on wastewater and exhaust gas,
b. Severe control on well water usage, and
c. Charge for saw-dust fuel.

10.7 Reduction of Production Cost and Increased Running Cost

Three CP measures (CP1, CP2 and CP3) were introduced for Winner Food Industries Sdn. Bhd. and the CP benefit is evaluated only by the reduction of running cost. Based on the performance confirmation data, reduced running cost was confirmed as follows:

(1) Reduction of Running Cost (Total Estimated Merit)

From data of continuous operation after CP introduction, the annual running costs were reduced as shown in Table 10-6 and detailed data is shown in Table 10-15.

Table 10-6 Comparison Table of Running Cost (After CP Introduction)

(RM/year)

		Before CP		After CP		Differ.
Rice washing machine	CW	$7m^3$/day	4,788	-	70	
Noodle cooling	WW	(incl. below)	-	(incl. below)	-	
Well water improve	CW WW	18 m^3/day 120 m^3/day	12,312 -	- 85 m^3/day	 5,661	
Total			17,100		5,731	11,369

Note CW: City Water WW: Well Water

The actual running cost saving was RM11,369 per year which is almost same to the planned cost saving, though actual and planned differ on each line, mainly because of city water consumption data accuracy.

However, if fixed costs of the construction investment are put aside, the saved cost and the increased cost cancel each other out, especially in cases of factories of this size. This will result in monetary disadvantage. Looking at the individual option, the momentary merit from rice washing machine is quite small compared to its investment. On the other hand, merit vs. cost is comparatively good for well water improvement. The rice washing machine is not used because of the low production rate compared with the machine's proper capacity (due to shortened operation time). For instance, in the case where 10 times production rate is realised, which is enough to use the machine, both raw water and wastewater profitability increase as shown in Table 10-7.

Table 10-7 Reduced Water Consumption and Wastewater Discharge

Unit: m^3/day

	Be	Af	Dif
City	70	0	70
Well	60	40	20
Wast	12	30	90

10.8 Financial Analysis

Winner Food Industries Sdn. Bhd. introduced 3 CP measures. CP1 is the rice washing machine and CP2 is the reform of a noodle cooling system. Both of them aim to reduce the consumption of city water. CP3 improves the quality of well water to be used instead of city water in the whole factory and primarily as boiler feed water.

Actual investment, cost saving and increased cost of each CP measure are shown in Table 10-8 and the calculated POT and IRR are shown in Table 10-9. The calculation for POT and IRR in total investment shown in Table 10-10 was made by using the data in Table 10-8 and methodology explained in 5.4.3.

Table 10-8 Investment and Cost Saving Data

		CP1	CP2	CP3	Total
Investment	RM	166,000	15,000	89,000	270,000
Cost saving	RM/y	5,000		12,000	17,000
Increased cost	RM/y			6,000	6,000

Table 10-9 POT and IRR for CP Measures

		CP1	CP2	CP3	Total
POT	year	Over 10years		Over 10years	Over 10years
IRR	%				Negative

Table 10-10 Calculation for POT and IRR in Total Investment

1,000RM

Year	0	1	2	3	4	5	6	7	8	9	10
Investment	270										
Cost saving		17	17	17	17	17	17	17	17	17	17
Increased cost		6	6	6	6	6	6	6	6	6	6
Interest		11	10	10	9	9	9	8	8	8	7
Income tax		-23	-6	-6	-6	-6	-6	-6	-6	-6	-5
Net cash flow	-270	23	7	7	8	8	8	8	9	9	9
Depreciation		76	22	22	22	22	22	22	22	22	22
Loan balance	270	247	240	233	225	217	209	201	192	183	174

The result of CP introduction was analyzed financially as follows.

CP1 reduces rice washing water to one tenth compared with the water consumption before the installation. The factory continues to use rinsing water as in the past. Therefore it is estimated that the total consumption of water in the washing and rinsing processes was reduced to about one third. CP1 equipment is rather expensive and the reduction of city water is not much because there is only one operation a day. Furthermore, POT is over 10 years. This means that the profitability of this investment is not favorable.

At present, washing and rinsing water are discharged without treatment. However, in the future authorities may regulate that only treated wastewater can be discharged in the future. If it is the case, it may require a large investment to treat the wastewater in a situation without CP1. The reduction of wastewater at the present time may help to decrease the amount of investment in the future. Additionally, CP1 can wash 10 times the present amount of rice. If production of noodle increases and more washing is needed in the future, CP1 can handle the increased production. From this point of view, it can be said CP1 has good potential.

CP2 reduces the water consumption and improves the noodle quality by cooling it rapidly. But almost no monetary merit comes from this CP installation as the company is already using well water in the factory, although this will decrease future investment for wastewater treatment because it reduces the amount of wastewater.

The profitability of CP3 is over 10 years in POT, which is also not good. CP3 is a special case of this model factory because the factory already has a well and can stop the purchase of expensive city water through the installation of this equipment. The model factory has almost completely switched from using city water to its well water. Therefore, although the system is not applicable to companies which do not have a well, it is attractive to companies that already have a well and use as much or more city water than the model factory.

The overall profits of CP1, CP2 and CP3 do not give a good profitability, where POT is over 10 years and the company can recover only one third of the investment in 10 years at 4 % interest because of the insufficient results of CP1, CP2 and CP3.

These CP measures cannot be recommended to other companies of the same size as the model factory at the present time because of low profitability. However, as far as the rice washing machine is concerned, it was confirmed that it is like a pilot plant, which can decrease the water consumption to less than one third of the consumption before the installation and also decrease the wastewater at the same ratio. Therefore, this type of rice washing machine will be very effective to a company that has a larger capacity than the model factory and needs wastewater treatment.

If the government strengthens the wastewater discharge regulations in the future, these measures will be profitable to small companies.

Therefore, potential benefits of CP measures are expected at the present time.

10.9 CP Benefit

It was confirmed that the model factory could reap the following benefits through the three CP measures.

(1) Through the reduction of city water, the model factory could decrease production cost by RM11,369 per year though some amount of running cost increased for using well water.

(2) From the financial analysis result, it is said that this project does not give a good profitability. However, it is thought that this project would make the following merits in the future.

a. Reduction of wastewater plant capacity:
The volume of wastewater was reduced by 30 % after the introduction of CP. Therefore, the capacity of the wastewater treatment plant to be installed in the future can be reduced accordingly. At the moment, however, there is no clear requirement for immediate installation of the wastewater treatment plant.

b. Increase of production capacity :
Introduced rice washing machine is designed for continuous operation, but there is only one operation a day. This machine can wash 10 times the present amount of

rice. If the model factory plans an expansion of its production capacity, it is not necessary to install a new rice washing machine. In the case where 10 times production rate is planned, both raw water and wastewater profitability increase as shown in Table 10-7.

Calculations of investment for CP measures for rice noodle processes in the model factory and general (larger) size factories in Table 10-11 show that construction cost per unit of rice reduces with a higher rate of rice treatment.

Table 10-11 Comparison of Construction Cost and Utility Consumption for Factory Size

	Model Factory Size (1 ton-rice/day)		General Size (10 ton-rice/day)	
	Before CP	After CP	Before CP	After CP
Water (m^3/day)				
- Consumption	13	4	130	40
- Wastewater	12	3	120	30
Investment (RM)				
- Rice wash mach. *1	10,000	100,000	100,000	100,000
- Wastewater treat. *2	100,000	50,000	756,000	189,000
(Total)	(110,000)	(150,000)	(856,000)	(289,000)
Investment per unit rice (RM 10^3 /ton)	110,000	150,000	85,600	28,900

Note *1 Rotary rice washing machine
*2 Activated sludge process

10.10 Recommendations

(1) Instructions to People of Each Ranks in Food and Beverage Industry

As described in section 10.1.2 “Observation of Pollution Control Condition”, none of the five factories is provided with water treatment facility. Now, the exception rule for water pollution control is applied; however this exception rule will be abolished sooner or later. It is thought that five factories did not install wastewater treatment plant due to lack of knowledge of present wastewater quality and wastewater treatment technology in addition to economical reason. Each factory produces different products, and therefore discharges various types of wastewater. However, it is thought that basic technology for wastewater treatment can be applied for all factories. For the purpose of improvement in wastewater treatment knowledge, it is recommended that the organisation in food and beverage industry give training opportunities for managers and engineers.

(2) Request to Supplier for Better Engineering Work

Normally, the construction work is carried out based on the drawings of equipment, machinery and piping submitted by suppliers; consequently users can confirm the easiness of operation, maintainability and optimisation of cost-saving before or during the construction work. However, it is also normal in the developing countries to carry out the construction work without detailed drawings concerned. If the following documents are kept after CP introduction, other CP options will be considered easily based on them. Therefore, it is also recommended that the organisation in food and beverage industry request all suppliers concerned to prepare and submit the following:

a. Technical calculation data,
b. Selection of equipment, material and piping size,
c. Plot plan for the installation of equipment and piping,
d. Process flow sheet, and
e. Construction drawings.

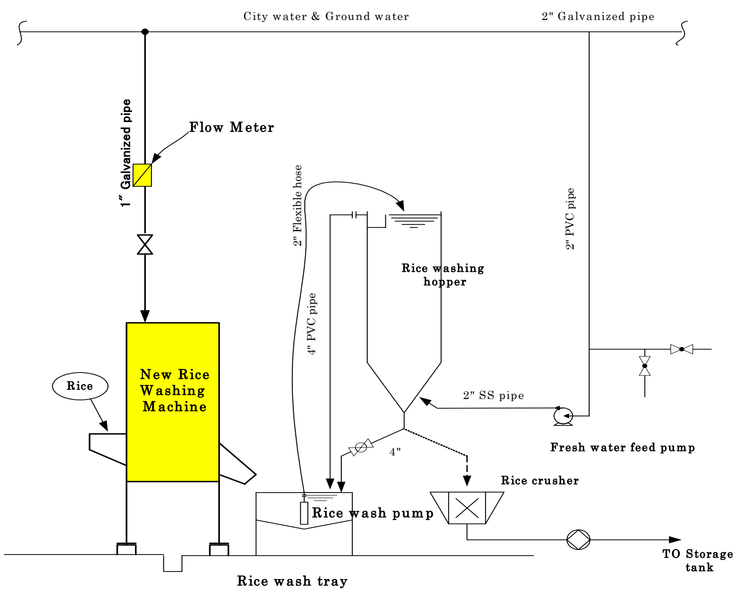

Figure 10-2 Flow Scheme of New Rice Washing Machine

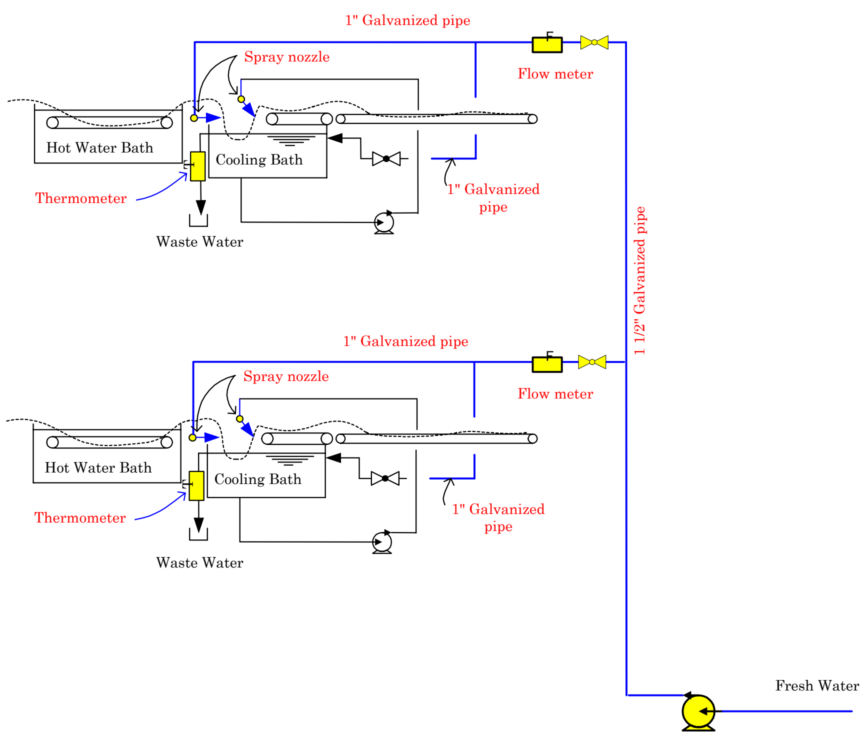

Figure 10-3 Flow Scheme of New Noodle Cooling System

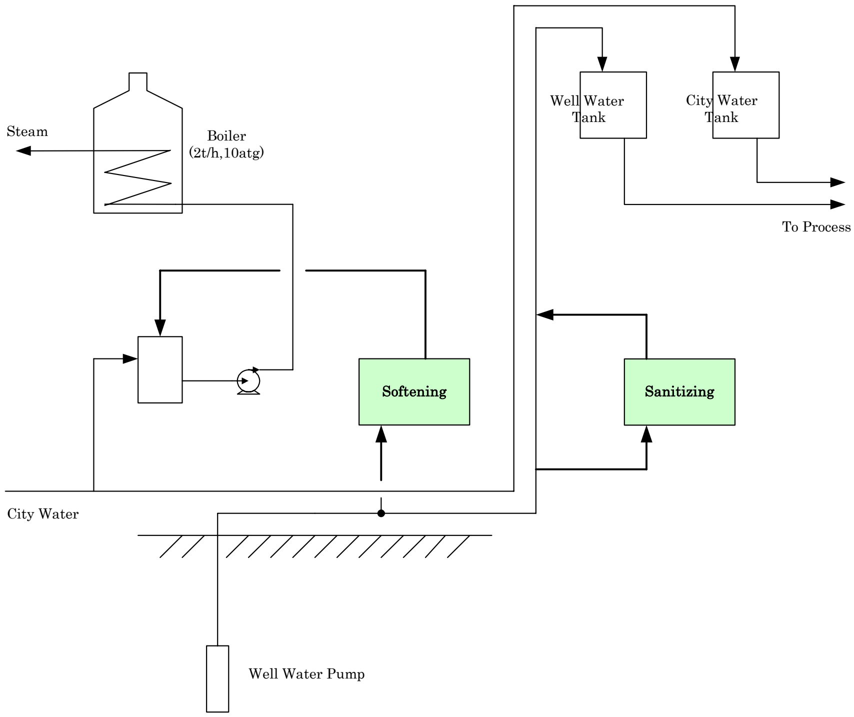

Figure 10-4 Flow Scheme of Well Water Treatment System

Table 10-12 Performance Confirmation Table for each CP

	Requisition by SIRIM and JICA Study Team (June 22'01)	Design Specification By Supplier (August 27'01).	Performance	
			Operation Data *	Confirmation
CP1 Installation of rice washing machine	1. Rice treatment: 1.5-3 t/h 2. Water: 3-4 times rice	1. Rice treatment: 2 t/h	1. Rice treatment: 1 t/0.5h 2. Water: 40 l/min. 3. 2nd rice Water: $5m^3$ x 0.5h	1. Rice treatment: 2 t/h 2. Total water: 4 m^3
CP2 Reform of noodle cooling system	1. Fresh spray: 2 m^3/h 2. Recycle: 2 m^3/h	1. Fresh spray: 1.2 m^3/h	1. Fresh spray: A line: 35 l/min. at 42℃ B line: 30 l/min. at 42℃	1. Water consumption: Same as before CP 2. More trial: Required
CP3 Improvement of well water treatment	1. Required chlorine: 0.5 ppm 2. Softener: 2 m^3/h Total hardness: 25 ppm Max.	1. Chlorine dosing; Pump: 0-1 l/h Sensor: 0-10 ppm Controller: 0-5 ppm 2. Softener: $2m^3/h$ Resin: 70 l Water: 2 m^3/h	1. Residual chlorine: 0.3-0.7 ppm 2. Total hardness: <0.1 ppm 3. Pump: 6 m^3/h 4. Bacillus: ND	1. Chlorine concentration: Fluctuate 2. Softener/AC Filter OK 3. Watch for long life: Required

*: Refer to Table 8-13 "Typical Data" and Table 8-14-1,2 "Water Analysis Data".

Table 10-13 Typical Operation Data

		Operating Data	
	Dec. 02, 2001	Dec. 27, 2001	Jan. 16, 2002
1. Rice washing machine			
1) Rice treated	1,000 kg	1,000 kg	1,000 kg
2) Charge time	6:57-7:28 (31 min.)	6:52-7:26 (34 min.)	10:10-10:40 (30 min.)
3) Flow rate	40 l/min.	40 l/min	40 l/min
2. Noodle cooling			
1) A line - Flow rate	35 l/min.	35 l/min.	35 l/min.
- Temperature	43℃	43℃	43℃
2) B line - Flow rate	30 l/min.	30 l/min.	30 l/min.
- Temperature	45℃	45℃	45℃
3. Well water Improvement			
1) Chlorine concentration	0.27 ppm	0.52 ppm	0.74 ppm
2) Flow rate	92 l/min.	88 l/min.	88 l/min.
3) Pump head	25 m	25 m	25 m
4) Activated filter			
- Inlet pressure	16 psi	16 psi	16 psi
- Outlet pressure	15 psi	14.5 psi	14.45 psi

Table 10-14 (1) Water Analysis Data

Sampling date: 06 December 2001

Test Parameters	Units	City Water	BFW	Well Water	AC Filter Outlet	Noodle Cooling Water	Test Method
Conductivity	μS/cm	90	189	199	200	196	APHA 2510 B
Arsenic	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 3120 B
Chromium, Hexavalent	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 3500-Cr D
Calcium	mg/l	10.1	< 0.1	32.0	31.4	31.4	APHA 3120 B
Silica, as SiO_2	mg/l	9.6	26.7	26.9	26.9	26.9	APHA 3120 B
Total Hardness, as $CaCO_3$	mg/l	28	< 1	89	87	87	APHA 2340 B
Total Nitrogen	mg/l	< 1	< 1	< 1	< 1	< 1	APHA 4500-N_{org} B
Total Evaporated Residue	mg/l	54	141	121	114	122	APHA 2540 B
Residual Chlorine	mg/l	0.8	< 0.1	< 0.1	< 0.1	< 0.1	APHA 4500-Cl G
Cyanide	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 4500-CN^- E
Total Plate Count	cfu/ml	ND(< 1)	2.3×10^2	1.1×10^2	7.7×10^3	1.9×10^3	APHA 9215 B
Bacillus Count	cfu/ml	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	APHA 9215 C (mod.)

ND : Not Detected

APHA: Standard Methods for the Examination of Water and Wastewater, 19th Edition 1995, American Public Health Association.

Table 10-14 (2) Water Analysis Data

Sampling date:07 December 2001

Test Parameters	Units	City Water	BFW	Well Water	AC Filter Outlet	Noodle Cooling Water	Test Method
Conductivity	µS/cm	90	191	195	202	201	APHA 2510 B
Arsenic	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 3120 B
Chromium, Hexavalent	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 3500-Cr D
Calcium	mg/l	10.3	< 0.1	31.1	31.1	31.2	APHA 3120 B
Silica, as SiO_2	mg/l	10.6	27.4	26.9	26.9	26.9	APHA 3120 B
Total Hardness, as $CaCO_3$	mg/l	29	< 1	76	76	76	APHA 2340 B
Total Nitrogen	mg/l	< 1	< 1	< 1	< 1	< 1	APHA 4500-N_{org} B
Total Evaporated Residue	mg/l	93	151	147	158	149	APHA 2540 B
Residual Chlorine	mg/l	0.4	<0.1	<0.1	<0.1	<0.1	APHA 4500-Cl G
Cyanide	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	APHA 4500-CN^- E
Total Plate Count	cfu/ml	2.0	8.2×10^2	1.0	2.2×10^2	1.7×10^2	APHA 9215 B
Bacillus Count	cfu/ml	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	APHA 9215 C (mod.)

ND : Not Detected

APHA: Standard Methods for the Examination of Water and Wastewater, 19^{th} Edition 1995, American Public Health Association.

Table 10-15 Comparison Table of Running Costs

Unit: yearly

	Unit Price	Before CP Introduction		After CP Introduction		Balance (A)-(B)
		Amount	Cost (A)	Amount	Cost (B)	
1. Rice washing machine						
1) City water	RM1.9/m^3	7 m^3/d x 360 d/y	RM4,788	-	-	
2) Well water	-	(6m^3/d x 360d/y) incl.below	-	(4m^3/d x 360d/y) incl.below	-	
3) Electricity	RM0.26/kWh	-	-	0.75 kWh x 2 x 0.5h x 360d/y	RM70	
			(RM4,788)		(RM70)	(RM4,718)
2. Noodle cooling						
1) City water	RM1.9/m^3	-	-	-	-	
2) Well water	-	(100 m^3/d x 360 d/y) including below	-	(80 m^3/d x 360 d/y) including below	-	
3) Electricity	RM0.26/kWh	-	-	-	-	
3. Well water improvement						
1) City water	RM1.9/m^3	18 m^3/d x 360 d/y	RM12,312	-	-	
2) Well water	-	120 m^3/d x 360 d/y	-	85 m^3/d x 360 d/y	-	
3) Electricity	RM0.26/kWh	-	-	1.5 kW x 7,000 h/y	RM2,730	
4) NaClO dosing	RM1.2/l	-	-	0.1 l/h x 7,000 h/y	RM840	
5) A/C recharge	RM5.5/l	-	-	400 l x 0.5/y	RM1,100	
6) Softener salt	RM0.9/kg	-	-	12 kg/cycle x 90 cycle/y	RM972	
7) Resin refill	RM5.5/l	-	-	70 l x 5 %/y	RM19	
			(RM12,312)		(RM5,661)	(RM6,651)
Total			RM17,100		RM5,731	RM11,369

Attachment

Surveyed Factories for Selection of Model Factory

The outline of the surveyed factories is described below.

1. Winner Food Industries Sdn. Bhd.

Refer to Section 10.2.

2. Awra Food Processing Sdn. Bhd.

2.1 Present Status

(1) Observation of pollution control conditions

The factory is new and commenced operations in August 2000. The machines and system are well studied and planned. There are not many problems at the moment because the environmental burden at the factory is small. However, DOE issued a recommendation on wastewater improvement in 2000, although both the amount of wastewater (3-4 m^3/day) and contaminant (3-4 kg-BOD/day) are small. A study for improving wastewater treatment is necessary. The boiler is for 2-3 t/h of hot water generation and has been designed to consume 20 l/h of diesel oil and emit 200 m^3/h of exhaust gas. As the actual operation rate is 50% or higher, there is no arising problem due to small impact to the environment.

(2) Waste Disposal, treatment and recycling

Almost all solid waste is generated from packing materials for products, raw materials and sub materials, and is reused, returned to original suppliers, or incinerated without any problem. Waste from production lines is captured by the grease-trap at the final exit where wastewater flows in with solid waste.

(3) Measures for Productivity Improvement

The freezing system is equipped with six ammonia reciprocating compressors and is the largest energy (electric power) consuming unit. The compressors are regulated as follows:

a. The working order of loader (load control system) is well designed among multiple compressors,
b. The flow of refrigerant is well designed so as to balance well among low temperature loads with different temperatures, and
c. The allocation of freezing rooms is well designed from higher temperature to

lower temperature so as to minimise the loss of cooled air.

2.2 CP Options

(1) Improvement of electric power factor

The power factor (cos ϕ) at the factory is currently around 0.8, which is not so good. By introducing an improvement regulator, the power factor can be improved to 0.96, which will contribute to concluding an advantageous purchase contract with the power company.

(2) Improvement of wastewater quality

Wastewater is discharged without sufficient treatment. Hence, a study for the installation of a simple activated sludge treatment system is required as recommended by DOE. In fact, the company is under discussion with a consulting company.

3. Cocoaland Industry Sdn. Bhd.

3.1 Present Status

(1) Observation of pollution control conditions

Wastewater and exhaust gas are the main subject for regulation of pollution control. The amount of wastewater is 30-40 m^3/day and concentration of contaminant sometimes exceeds 4,000 mg/l. Both the amount and quality fluctuate extremely. Although the amount of wastewater is estimated less than the daily regulation standard of 60 m^3/day, the quantity of BOD discharged is estimated at 180 kg/day, which is much higher than the daily discharge standard of 6 kg/day. However, as these estimates are based on a small number of samples and further analyses are required. The majority of wastewater comes from a vacuum system as cooling water, which the company is successfully striving to reduce; however, the concentration of contaminant in cooling wastewater is not so high. Therefore, further study is required to find the cause of high concentration of pollutants in wastewater discharged.

The exhaust gas is generated by burning 150-200 l/h of diesel oil at boilers with designed capacity of 1.6 t/h, and emitted at 1,500-2,000 m^3/h. As the actual operation rate is around 50%, actual exhaust volume is less. As the temperature of exhaust gas is over 200℃, waste heat can be recovered as hot water, which is used as boiler feed water (BFW) or in other production lines. As for BFW, steam condensate is recovered from process vessels with hot water jackets or others.

(2) Waste Disposal, treatment and recycling

There is no specific matter to be described because the amount of waste is small.

(3) Measures for Productivity Improvement

The process of soft candy production consumes an extremely high amount of energy in the factory. The first half of the process stage, which has a sugar dissolving unit to mix and melt sugar, water and additives, is similar to a chemical plant. The last half of the process is a molding (to form candies) unit, which is quite different from the former. The most prospective improvement of productivity would be to realise continuous operation, which is now batch-wise. Small troubles in the molding unit induce occasional stops of the entire system, though the factory is making daily efforts to prevent such troubles. It is expected that regular maintenance and modification of the unit will allow continuous and smooth operation of the system.

3.2 CP OPtions

(1) Effective operation of steam boiler

The combustion efficiency of a boiler depends greatly on the amount of excess air. By regulating the excess air ratio by controlling the opening of an air-inlet valve, and the revolution rate of the air blower, based on the measurement of residual oxygen in exhaust gas, considerably better efficiency will be attained. However, in the case of small boilers or intermittent operation, the expected benefit by this method is not large.

(2) Control of fouling factors

With fouling of heat conductive surfaces of evaporating pipes of boilers, heat exchangers and jackets of vessels, heat efficiency becomes worse. It is suggested that the factory periodically maintain heat conductive surfaces clean or decide a cleaning schedule by recording and investigating the trend of the inlet and outlet temperature of heating and heated fluids.

(3) Heat recovery from exhaust gas

As exhaust gas is emitted with the temperature over 200℃, heat can be recovered to generate hot water. Heat recovered is expected at 25,000 kcal/h (1,500 m^3/h, Cp=0.25, d=0.7, temperature difference=100℃), but caution is necessary for intermittent operation of the boiler.

4. Universal NutriBeverage Sdn. Bhd.

4.1 Present Status

(1) Observation of pollution control conditions

Wastewater and exhaust gas are small in amount and not a problem, even though they are discharged without any treatment. The wastewater quality is good because there is direct contact to the production process. It can be recycled and reused, although underground water is free of charge.

(2) Waste Disposal, treatment and recycling

There is no specific matter to be described because the amount of waste is small.

(3) Measures for Productivity Improvement

The main unit in the production process is the dissolving section, where sugar is mixed with water and dissolved. Based on the product specification, the ratio of sugar and water is changed and necessity of steam heating is judged.

4.2 CP Options

(1) Water and heat recovery of steam condensate

At present, steam condensate is discharged to a ditch after indirect heating of a sugar solution in sugar dissolvers equipped with heat exchangers. Steam condensate can be recovered and recycled because it is clean and has enough temperature.
On the other hand, hot sugar solution is cooled down from 90℃ to 30-40℃ by a heat exchanger through indirect cooling. The cooling water, which is also clean and warm, can be recovered and reused although it is currently discharged straight to a ditch.

(2) Pressure-down of steam supply

The steam supply pressure from the boiler is around 10 kg/cm^2G, while the required pressure is 1 kg/cm^2G which corresponds to required temperature of 80-90℃ for the dissolver. Therefore, the supply pressure can be reduced to 2-3 kg/cm^2G including some margin of pressure drop and others. However, the amount of fuel saved by this method is not so large.

5. Vit Makanan (KL) Sdn. Bhd.

5.1 Present Status

(1) Observation of pollution control conditions

Wastewater and exhaust gas are the main subject for regulation of pollution control. As the amount of wastewater and contaminant (BOD) are estimated to be below the daily regulation standard of 60 m^3/day and 6 kg BOD/day respectively, there is no problem at the moment. Exhaust gas is emitted from a comparatively large boiler with a capacity of 5.6 t/h of steam generation. As the operation rate of the boiler is less than 50%, no problem occurs at the moment.

(2) Waste Disposal, treatment and recycling

There is no specific matter to be described because the amount of waste is small.

(3) Measures for Productivity Improvement

The factory is newly established with new and the latest machines and production process system. For example, heating steam for a noodle fryer is perfectly recovered as boiler feed water (BFW) and recycled, hence the temperature of BFW reaches 70℃.

5.2 CP Options

At present, steam consumption and well water usage amount is not large because the system is well designed. Therefore, there are no recommended measures for CP introduction. However, it is recommended that meticulous maintenance be carried out to prevent steam leakage and to achieve a good working environment and to raise employees' morale.

Demonstration Project for Cleaner Production
in Food Processing Sub-sector (Noodle Manufacturing Factory)

Model factory: Winner Food Industries Sdn. Bhd.

Study tour (28 June 2002)

Rice Washing Machine

Spray System for Noodle Cooling

Underground Water Softening System

CHAPTER 11

DEMONSTRATION PROJECT IN THE TEXTILE SUB-SECTOR

CHAPTER 11 DEMONSTRATION PROJECT IN THE TEXTILE SUB-SECTOR

Model Factory: South Asia Textiles (M) Sdn. Bhd.

11.1 Factory Survey Results (General)

11.1.1 Surveyed Factories and their Outline

During the first field survey, the following six representative companies were audited:

(1) South Asia Textiles (M) Sdn. Bhd.
(2) Berjaya Knitex Sdn. Bhd.
(3) Sykt Perusahaan Finetex Sdn. Bhd.
(4) Sykt Koon Fuat Industries Sdn. Bhd.
(5) M.K.K. Industries Sdn. Bhd.
(6) Samtex Industries Sdn. Bhd.

Over the course of the factory survey, the following general characteristics of the dyeing industry in Malaysia were found:

a. Production materials are mainly plain dyeing on 100% cotton and polyester and cotton (T/C) blended knitted fabrics. Disperse dyes are used for polyester dyeing and reactive dyes are primarily used for cotton dyeing. The fixing rate of normal reactive dye is generally lower and double anchor type reactive dye has higher fixing rate. However, double anchor type reactive dye is much more expensive than conventional type and it is not used much.

b. Dyeing is done by primarily by winch type and liquid flue (jet dyeing) type machines. They are imported from various countries such as Japan, Taiwan, Korea and Europe. Some of them are second hand and their energy efficiency is low. As production is not stable, it seems as if the machines are free much of the time, because the machine used are fixed on cotton 100% dyeing case and on T/C dyeing case.

c. Well water, river water, and city water are used for dyeing processes and the city water price is continuously increasing. Therefore, use of recycled water for process water is a suitable topic for study.

d. Wastewater treatment facilities are installed in each dyeing factory and wastewater is discharged to the river directly. The wastewater is colored but it is not regulated at present.

e. The sludge generated at the wastewater treatment is consigned by one company Kualiti Alam and collected sludge is treated mainly as landfill at present.

The outline of each factory is as follows and present status and CP options for each factory are described in Attachment.

(1) South Asia Textiles (M) Sdn. Bhd.

The production is solely done for the dyeing of garments and this factory has a large capacity full-dress wastewater treatment plant including an activated sludge system. This factory has high consideration for countermeasures for industrial pollution and reducing city water consumption by recycling the treated water from the wastewater treatment plant.

(2) Berjaya Knitex Sdn. Bhd.

The factory has good process equipment including Computerised Colour Matching (CCM). The productivity is quite good for dyeing of a variety of goods. They are now studying to remodel the existing wastewater treatment plant that has some shortcomings.

(3) Sykt Perusahaan Finetex Sdn. Bhd.

The factory has good productivity and has an in-house raw water and wastewater treatment plant that is running well. The factory is highly concerned with color removal from wastewater as to meet environmental regulations. This factory is also conscious of the usefulness of portable and easy-to-use analysis equipment for wastewater and has used them. The factory area is quite large and has sufficient space for the introduction of any CP measure.

(4) Sykt Koon Fuat Industries Sdn. Bhd.

The factory's own raw water supply facility has large enough capacity for increased production in the future and it is operated very well. The wastewater treatment plant is also operated well but it seems that its capacity is not sufficient for the maximum production.

(5) M.K.K. Industries Sdn. Bhd.

This factory is processing raw materials from overseas customers and their productivity will improve as they were planning to introduce new process technology equipment, and CP equipment, and to improve the wastewater treatment facility.

(6) Samtex Industries Sdn. Bhd.

The productivity of this factory is quite good despite the limited factory area. The factory has its own wastewater treatment plant designed by a consultant but it appears that it is not maintained well.

11.1.2 Observation of Pollution Control Condition

The wastewater from dyeing process and exhaust gas from the boiler at the six factories surveyed are the common objects regulated by pollution control. Every factory has wastewater treatment facilities. According to the analysis results of sampling at the factories, they cleared most of the Malaysian effluent standard-B (Sewage and Industrial Effluents for Standard B), except the COD. At some factories there are a few items which exceed the standards. In these factories, the following measures are required for study:

a. Counter measure for the reduction of wastewater from dyeing process,
b. Improvement of operational method at wastewater treatment system,
c. Reduction of wastewater generated from production process, and
d. Expansion of capacity for wastewater treatment system.

All factories use heavy oil or natural gas as boiler fuel. The SO_2 and NO_x concentration in boiler exhaust gas of six factories have cleared the Malaysian regulatory standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel.

11.1.3 Waste Disposal, Treatment and Recycling

All six factories generate sludge from the precipitation tanks in the wastewater treating facilities. They consign further sludge treatment to outside waste treating company, Kualiti Alam Sdn. Bhd. The sludge discharged from dyeing houses contains lower amounts of hazardous substances such as heavy metals, or contains none at all. For the reduction of pollutant load, the selection of dyes and auxiliary agents should be carefully conducted considering the influence on wastewater and sludge quality. Only South Asia Textiles (M) Sdn. Bhd. recycles the treated wastewater to use for in the washing process at the past recycling rate of 30%. They intended to raise this rate to 70%.

11.1.4 Measures for Productivity Improvement

The following are measures undertaken by several factories surveyed to improve productivity in the dyeing process:

a. High-speed jet dyeing machine (in Sykt Koon Fuat Industries Sdn. Bhd.),
b. Fully-automatic and computer-controlled dyeing machine (underway in M.K.K Industries Sdn. Bhd.), and
c. Improving flexibility for the change of raw material by switching operation between conventional temperature type for cotton and high pressure type dyeing machine for polyester. (in Samtex Industries Sdn. Bhd.).

The following marketing strategies in textile business are also to be noted:

a. Conducting both business of knitting and dyeing (in Berjaya Knitex and Sykt Perusahaan Fintex Sdn. Bhd.), and
b. Conducting both business of garment dyeing and garment washing (in South Asia Textiles (M) Sdn. Bhd.

11.1.5 CP Options in the Textile Sub-sector

Heat recovery, reduction of electricity consumption and improvement of wastewater were the common issues of CP introduction for the six factories. The CP measures are classified as follows:

(1) Heat recovery:
   a. Improvement of boiler efficiency
   b. Reduction of heat loss from steam line
   c. Reduction of heat loss from steam condensate line
   d. Recovery of steam condensate
(2) Reduction of electricity consumption:
   a. Improvement of electricity power factor
(3) Improvement of wastewater:
   a. Improvement of wastewater quality
   b. Improvement of wastewater treatment efficiency
   c. Improvement of water recycling ratio

Targeted field for CP options are shown in Table 8-1.

Table 11-1 Targeted Field for CP Options

Company / CP Items	A	B	C	D	E	F
1. Heat recovery						
a. Improvement of boiler efficiency	X	x	x	x	x	x
b. Reduction of heat loss from steam line		x	x	x	x	x
c. Reduction of heat loss from steam condensate line						x
d. Recovery of steam condensate						x
2. Reduction of electricity consumption						
a. Improvement of electricity power factor		x				
3. Waste						
a. Improvement of wastewater quality		x	x	x	x	
b. Improvement of wastewater treatment efficiency					x	
c. Improvement of water recycling ratio	X					

Note-1: A、B、C etc. represent company as follows.

A: South Asia Textiles (M) Sdn. Bhd.
B: Berjaya Knitex Sdn. Bhd.
C: Sykt Perusahaan Finetex Sdn. Bhd.
D: Sykt Koon Fuat Industries Sdn. Bhd.
E: M.K.K. Industries Sdn. Bhd.
F: Samyex Industries Sdn. Bhd.

Note-2: "x" means applicable CP options.

11.1.6 Selection of Model Factory

Refer to CHAPTER 5, section 5.2 "Selection of Model Factories".

South Asia Textiles (M) Sdn. Bhd. was selected as a model factory in the textile sub-sector.

11.2 Status of the Selected Model Factory before CP Introduction (South Asia Textiles (M) Sdn. Bhd.)

(1) Outline of the Factory

This factory is dyeing products (10%) and washing final products (90%) of 100%, cotton and polyester and cotton blended materials (T/C), which are dyed or printed at another factory before. As the main machines, rotary type dyeing machines, closed type vertical washing machines and rotary type dryers are installed.

(2) Observation of Pollution Control Conditions

Items under regulatory pollution control at the factory are wastewater discharged from the dyeing process and exhaust flue gases from the boiler**.**

The analysis results of wastewater sampled at the factory generally fulfill the Malaysian effluent standard-B except the COD as shown in Table 11-2. The existing wastewater treatment facility is composed of aeration, electrolysis, sand filter and an activated carbon filter process as shown in attached Figure 11-3.

The SO_2 and NO_x concentration in boiler exhaust gas observes the Malaysian standards, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel. Approximately 30% of the treated wastewater is recycled to the washing process to reduce the city water consumption. The factory is eager to increase this recycling ratio from the past 30% to 70% as use as process water to reduce the consumption of city water. Additionally, though the factory seems to have advanced energy consumption reduction measures aggressively, there is room for improvement and heat loss recovery from the steam boiler needs to be studied.

Table 11-2 Analysis Data of City Water and Wastewater (Before CP Introduction)

Parameter	Unit	Wastewater				Regulation Standard B
		City Water	Aeration Tank	After Electroly -sis	Final Discharge	
Temperature	℃	29.1	36.5	36.3	30-35	40
PH	-	-	6.9	6.6	6.8-8.0	5.5-9.0
Electric Conductivity	μS/cm	115	703	631	770-872	-
Turbidity	NTU	1/50	243	46.2	2.3-10.1	-
Oil &Grease	mg/l	<10	<10	<10	<10	10
BOD at 20℃	mg/l	4	170	32	10-70	50
COD	mg/l	50	555	200	80-290	100
Dissolved Oxygen	mg/l	4.2	2.8	3.9	3.4-4.5	-
Suspended Solids	mg/l	1	232	60	2-20	100
Total Nitrogen	mg/l	4.6	17.7	8.5	5.2-6.5	-
Nitrate Nitrogen	mg/l	0.24	<0.01	<0.01	<0.01	-
Sulphate	mg/l	33.3	92.3	108	90-160	-
Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	2
Phosphate as P	mg/l	<0.1	<0.1	<0.1	<0.1	-
Cyanide	mg/l	<0.05	<0.05	<0.05	<0.05	0.1
Fluoride	mg/l	0.5	0.5	0.6	0.5-0.7	-
Iron	mg/l	(<0.01)		(3.6)		5

(3) Waste Disposal, Treatment and Recycling

The quantity of sludge generated from the wastewater treatment plant is around 800 kg/month as solid. It is dehydrated by a filter press and dried up in the sun in a drum.

About one ton of sludge per month (water content around 20%) is consigned to Kualiti Alam Sdn. Bhd. on commissioning.

(4) Measures for Productivity Improvement

Different from a general dyeing factory, this factory conducts both the business of garment dyeing and washing, including stone wash finishing, of garments dyed at another factory. This factory is trying to develop garment partial dip dyeing and squeezing dyeing as new businesses.

11.3 CP Options in the Model factory

Present problematic issues in the factory that need CP measures were summarised as follows:

(1) Improvement of steam boiler efficiency, and
(2) Increase of treated wastewater recycling ratio.

(1) Improvement of Steam Boiler Efficiency

To improve steam boiler efficiency, the most prospective measure was the recovery of waste heat from the exhaust flue gas (temperature: about 180-200℃), by using a heat-exchanger between the in-take of air and flue gas. However, this measure was not recommended because it was not economically feasible for the small size boiler that was used in the factory, although a compact rotating heat exchanger (Ungstrohm Type) was available in the market.

(2) Increase of Treated Wastewater Recycling Ratio

The factory was considering reusing treated wastewater in the washing process at the initial stage of operation under steady and economic conditions. After several trial operations, the recycling ratio of the treated wastewater had increased to 30%. However, further increase of recycling was constrained by the presence of high iron ion concentration in the treated water. The factory stated that during the washing operation iron ion in the treated water changed pale colour products to deep colour products. Therefore, existing treated water could not be used for the washing of pale colour products, but could only be reused for deep colour products. The factory found that if the iron ion content could be reduced from existing levels of more than 5.0 mg/l to less than 0.1 mg/l, it would be possible to recycle treated water for the washing of pale colour products.

11.4 CP Measures

11.4.1 Selected CP Measures

Taking into account of the present situation mentioned above, it was proposed that the following one CP measure be implemented in the factory:

(1) Increase of treated wastewater recycling ratio

(1) Increase of Treated Wastewater Recycling Ratio

For the reduction of iron ion content in the wastewater, there are several methods, as shown in Table 11-10, that are already applied in some industries.

The RO method seems to be suitable for the removal of iron content only, as it reduces running costs and sludge treatment fees. But the installation cost of the equipment is around 5-10 times higher than the cost of the existing system and capacity for electrolyte removal is not as high as expected. Moreover the recovering membrane seems to have some problem. Several laboratory scale tests were conducted at the SIRIM laboratory by SIRIM and the Study Team, and it was concluded that a coagulation method using chemical agents could reduce the iron ion concentration from more than 5.0 mg/l to 0.1-0.05 mg/l. Based on the above results, it was planned to add a new wastewater treatment plant to the existing plant, and it would be possible to increase the recycling ratio of the treated wastewater from 30% to 70%.

11.4.2 Outline of CP Measures

(1) Layout

Figure 11-4 and 11-5 show a general plot plan of the factory and plot plan for the new plant respectively. The new plant is installed next to the existing plant, located in adjustable area.

(2) Basic Flow Scheme

A process flow scheme for removing iron in the wastewater is shown in Figure 11-1. Dissolved ferrous ion in the wastewater is oxidized to ferric ion and deposited by Na-hypo-chlorite (NaClO). The pH value is adjusted by caustic soda (NaOH) or hydrochloric acid (HCl). Then the deposited iron substances are coagulated-flocculated by poly-aluminum chloride (PAC) and poly-acryl-amide (PAA) based polymer, removed by clarifier and filtrated with multi-media filter.

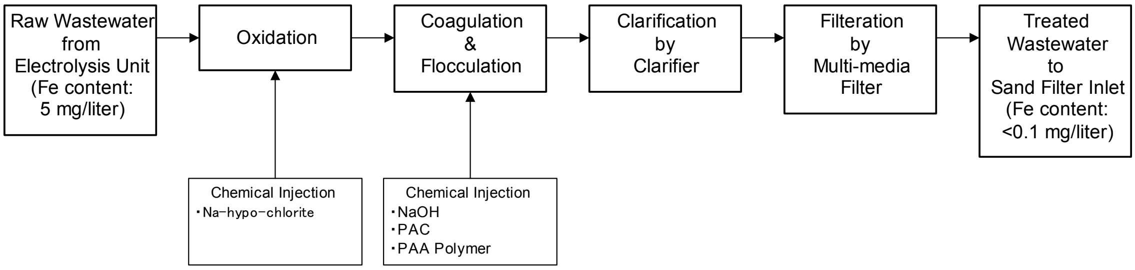

Figure 11-1 Process Flow Scheme for Removing Iron Ion

Process flow sheet of the new plant is shown in attached drawing, Figure 11-2. Feed water for the new plant is taken from the outlet line of the settler after electrolysis in the existing plant and it is returned to a sand filter feed drum after a sand filter as shown in attached drawing, Figure 11-3.

(3) Design conditions and specification for major equipment

The design conditions were finalised as follows:

a. Wastewater treatment capacity: $30m^3/h$ maximum as feed rate
b. Working hours: 20 hours per day, 6 days per week
c. Source of wastewater: Treated wastewater after electrolysis
d. Water specification of feed water: Total iron content; more than 5.0mg/l
e. Water specification of treated water: Total iron content; less than 0.1mg/l

Table 11-3 shows major equipment and their specification.

Table 11-3 Major Equipment and Specification

Name of equipment	Quantity	Specification
Chemical injection tanks and dosing system	5	For sodium hydrochlorite, sodium hydroxide, hydrochloric acid and polymer 5 chemical injection pumps
Chemical mixing tanks	3	Capacity: 2.5 m^3 per each Material: Mild steel with epoxy lining with 3 agitators
Clarifier	1	Cylindrical venture type Dimension: 4.85 m diameter x 3 m height
Multi media filter	1	Material: Carbon steel with epoxy coated Dimension: 60 inch diameter x 72 inch height

Note: Outline drawings of clarifier and multi media filter are shown in attached Figures 11-7 and 11-8 respectively.

(4) Expected Effects

By introduction of this CP measure, direct effects and indirect effects are expected as follows.

a. Direct effects:
   (i) Reduction of city water consumption, and
   (ii) Reduction of wastewater discharge amount.

b. Indirect effects:
   (i) Reduction of environmental load of wastewater.
   At present, the wastewater is discharged to the river or sewer free, but it would be charged in future.
   (ii) Image up of the factory and dyeing industry.
   This will influence factory management and business.
   (iii) Ripple effect to other dyeing factories
   If the technology is applicable to other factories, the ripple effect is expected.
   (iv) Reduction of investment for public wastewater treatment and city water supply facility.
   If many factories can reduce the consumption of city water and wastewater discharge amount, the effects will be significant.

(5) Estimated Investment Cost

The total investment cost for introduction of this CP measure was estimated at around RM330,000.

(6) Estimated Running Cost

The total running cost for the operation of this new plant was estimated at around RM0.2/m^3 -feed water. This running cost includes chemical consumption, electricity consumption and sludge disposal cost.

(7) Schedule

Refer to CHAPTER 7 “Implementation Schedule”.

For South Asia Textiles (M) Sdn. Bhd., the completion of construction work was scheduled at the end of November 2001, and the final test operation was also performed at the end of November 2001 on schedule.

11.5 CP Investment

The total investment cost resulted in RM305,000, and it included the total cost of design, application for DOE, equipment and machinery, transportation and construction, spare parts and consumables, and commissioning and operator's training as shown in Table 11-4.

Table 11-4 Investment Cost for New Plant

No.	Item	Quantity	Amount (RM)
	Wastewater treatment plant	1 set	305,000
Total			305,000

In the investment, machinery and equipment (RM222,500) , construction material and consumable (RM38,000) and transportation and construction (RM28,000) are included. All civil work, piling and all underground RC pits were prepared by the model factory.

11.6 Performance Confirmation

It was necessary to confirm the reduction condition of iron ion content in the treated wastewater after CP introduction. In addition, a residual chlorine content problem and a smell problem were found in the treated wastewater during test operation. However, all of them were dissolved as described below.

(1) Reduction of Iron Ion Content in the Treated Wastewater

Analysis results of treated wastewater by newly installed plant for CP introduction are shown in Table 11-5**.**

The reduction of iron ion content in the treated wastewater was confirmed as follows:

a. Fe^{3+} and total iron ion concentration was higher than the target value of 0.1mg/l in January 2002 as shown in Table 11-5.
b. It was found that pH value of treating water in the coagulation tank was higher (pH7-9) against the designed optimum value of 5-7.
c. It was also found that there was some amount of iron rust in the multi media filter.
d. The pH value was controlled between 5-7 and back washing operations for the multi media filter were carried out in March 2002.
e. It was confirmed that iron ion content was reduced to less than 0.1 mg/l in March 2002.

Table 11-5 Analysis Result of Treated Wastewater from the New Plant

Sampling Point		Inlet Water			Outlet Water		
Sampling Month		Nov. 2001	Jan. 2002	Mar. 2002	Nov. 2001	Jan. 2002	Mar. 2002
Parameter	Unit						
Fe^{+2}	mg/l	0.91	0.38	-	<0.05	0.10	-
Fe^{+3}	mg/l	6.90	9.27	-	<0.05	**0.17**	-
Total iron ion	mg/l	7.81	9.65	7.00	<0.10	**0.27**	<0.10
PH	-	6.8	8.8	7.0	7.1	7.1	6.5
Conductivity	μ S/cm	924	1,515	-	1,120	1,825	-
COD	mg/l	193	156	220	141	146	180
SS	mg/l	27	23	-	4	5	-
TDS	mg/l	508	759	-	484	861	-
Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note : A few samples were taken and analysed in each month, and only average figures are shown in the table.

(2) Reduction of Residual Chlorine Content in the Treated Wastewater

The residual chlorine content in the treated wastewater was less than 0.1 mg per litre by ordinary analytical method as shown in Table 11-5. However, it was found that a small amount of residual chlorine would be remained in the treated wastewater and it smelled slightly. The reduction of residual chlorine content in the treated wastewater was also confirmed as follows:

a. The injection rate of Na-hypo-chlorite (NaClO) was higher than design value.
b. The existing activated carbon filter was old and did not work effectively.
c. The injection rate of Na-hypo-chlorite (NaClO) was reduced to the design value.
d. A new activated carbon filter was installed as shown in attached Figure 11-9.
e. Finally, it was confirmed there was no residual chlorine smell in the treated wastewater.

The adjustment operation of the chemical injection rate is very important not only for the reduction of residual chlorine content in the treated wastewater but also for the prevention of the waste of chemicals. Therefore, an operational standard for chemical injection was prepared as shown in attached Table 11-11 and it was informed to the factory.

(3) Elimination of Smell in the Treated Wastewater

It was found that the treated water smelled of something after CP introduction. Elimination of the smell was confirmed as follows:

a. The operation load of the production facility in the factory was low and the water level in the existing aeration tank was also low. Therefore, the wastewater was not aerated sufficiently and some bacterium was propagated in the treated wastewater storage tank.

b. It was also found that residual chlorine was causing smell and the smell could be removed by the activated carbon filter.

c. After normal operation of the aeration tank at higher water level, smell was eliminated, and BOD and COD values in the treated water were also reduced to 50-60 mg/l.

d. In addition, a new storage tank for treated wastewater was also installed as shown in attached Figure 11-9 because the existing holding tank was too small and old.

So there was a reduction in the limitation on the use of the treated wastewater for recycling use as process water such as rinsing or washing water. However, in mid-March 2002, the recycling ratio of the treated wastewater was still 30% as before. The factory informed that the production facility was operated at lower load and it would be operated higher load from August 2002. Therefore, it will take time for increasing recycling ratio as confirmation of product quality. The recycling ratio will increase from August 2002. Therefore, the total estimated cost reduction calculations are conducted based on a recycling ratio of 70%.

11.7 Reduction of Production Cost and Increased Running Cost

From performance confirmation data, necessary running cost was calculated first. Then, reduction of city water consumption fee was calculated using the running cost data.

(1) Increased Running Cost

The running unit costs for the operation of the new plant were calculated based on the performance confirmation data as follows:

Chemicals :	RM0.206/m^3-feed water
Electricity :	RM0.065/m^3-feed water
Sludge disposal :	RM0.012/m^3-feed water
Total :	RM0.283/m^3-feed water

Their detailed calculation is shown in Table 11-6.

Table 11-6 Calculation Data for Running Cost

a. Chemicals consumption cost:				
Chemicals		Injection Ratio	Unit Price	Running cost (RM/m^3)
NaClO	10% liquid	40 mg/litre	RM1.50/kg	RM0.06
NaOH	50% liquid	36mg/litre	RM0.90/kg	RM0.0324
PAC	18% liquid	50mg/litre	RM1.80/kg	RM0.09
PAA	Polymer	2mg/litre	RM12.00/kg	RM0.024
	Total			RM0.2064

b. Electricity consumption cost:	
Electricity unit price:	RM0.26/kWh
Consumption:	7.5 kWh/30m^3-design flow rate
Running cost:	7.5 kWh x 0.26 = RM1.95/30m^3= RM0.065/m^3

c. Sludge disposal cost:	
Disposal unit cost:	RM480/t (RM0.00048/g)
Disposal sludge amount	25.8 x 0.8 = 20.64 g/m^3
Disposal cost:	0.00048 x 20.64 = RM0.01/m^3

Here,

a. Each chemical is consumed for the following purpose:

Na-hypo-chlorite (NaClO):	for oxidation
Caustic soda (NaOH) or Hydrochloric acid (HCl):	for pH adjustment
Poly-aluminum chloride (PAC) and Poly-acryl-amide (PAA):	for making good flocculation

b. The electricity consumption was calculated from the capacity of each equipment

c. Generated sludge amount was calculated from the added amount of chemicals and iron ion concentration to be removed. However, suspended solid (SS) amount was not calculated because this SS was generated at existing process only.

(2) Total Estimated Merit

The cost reduction effect is calculated at the recycling ratio of 70%. Calculation is done by comparing the cost difference between the cost reduction of saving city water and the cost increase of running cost by operating the new plant.

Present and expected conditions for the calculation of estimated merit were considered as follows:

a. Unit price of city water: RM2.24/m^3

b. Present city water consumption: 420 m^3/day

c. Present recycling ratio: 30 %

d. Expected recycling ratio: 70 %

e. Operating days: 300 days/year

Based on the conditions mentioned above, a calculation for the total estimated cost reduction by introducing CP measure became as follows:

City water consumption: 420/0.7 = 600 m^3/day (Recycling ratio = 0)

Expected city water consumption: 600 x 0.3 = 180 m^3/day

Reduced city water consumption: 420 – 180 = 240 m^3/day

= **72,000 m^3/year**

Expected cost saving by reduction of city water consumption:

2.24 x 240 x 300 = RM161,280/year

Total running cost: RM0.283/m^3 x 600 m^3/day x 300 d/year

= RM50,940/year

Therefore,

Total expected cost saving: RM161,280 – RM50,940

= **RM110,340/year**

Therefore, total expected cost saving will be as follows:

a. Reduction of consumption of city water: 72,000m^3/year

b. Reduction of purchasing amount of city water: RM110,000/year

c. Reduction of effluent amount of wastewater: 72,000m^3/year

The higher the recycling ratio, the more cost reduction merit, as shown in Figure 11-2. From this figure, it can be said that the cost reduction merit becomes more than RM150,000 per year, if the recycling ratio increases to 80%

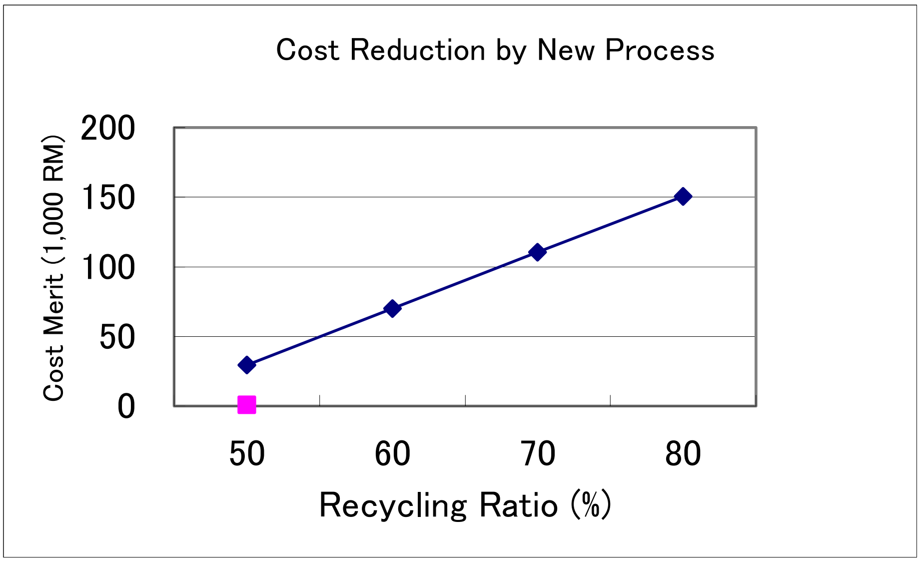

Figure 11-2 Cost Reduction Amount vs. Recycling Ratio

11.8 Financial Analysis

The model factory, which has already recycled treated wastewater by 30% in the production process, introduced a CP measure which is a new waste treatment system as described before. It is expected to reduce the consumption of city water by treating wastewater and increasing the recycling ratio of the treated wastewater. The model factory is doing trial operation of the CP equipment installed. Iron ion, which is the main target elimination by the CP measure in order to improve the quality of the recycling water, was successfully removed. However, from the viewpoint of profitability, the most important thing is to know how much the factory can increase recycling ratio of the treated wastewater and how much the consumption of city water can be reduced by the measure.

The target was set to increase the recycling ratio from the past recycling ratio of 30% to 70 %. It was already confirmed that iron ion concentration in the treated wastewater had reduced to less than 0.1 mg/l. However, it was impossible to increase the recycling ratio right away, because it required checking the production quality step by step as the factory would want to increase the recycling ratio.

As of March 2002, the recycling ratio was not increased. Therefore, only trial calculations for the profitability, POT and IRR, are made and the data and the calculated results are shown in Tables 11-7 and 11-8. The calculation for POT and IRR at a level of 70% recycling shown in Table 11-9 was made using the data in Table 11-7 and methodology explained in 5.4.3.

Table 11-7 Investment and Cost Saving Data

Recycling ratio		50%	60%	70%	80%
Investment	MR	305,000	305,000	305,000	305,000
Cost Saving	MR/y	81,000	121,000	161,000	202,000
Increased cost	MR/y	51,000	51,000	51,000	51,000

Table 11-8 POT and IRR for CP Measure

Recycling Ratio		50%	60%	70%	80%
POT	year	Over 10years	5.8	3.7	2.7
IRR	%/y	2	16	27	38

Table 11-9 Calculation for POT and IRR in 70% Recycling Case

1,000RM

Year	0	1	2	3	4	5	6	7	8	9	10
Investment	305										
Cost saving		161	161	161	161	161	161	161	161	161	161
Increased cost		51	51	51	51	51	51	51	51	51	51
Interest		18	13	8	4	0	0	0	0	0	0
Income tax		2	22	23	25	26	26	26	26	26	26
Net cash flow	-305	90	75	78	82	84	84	84	84	84	84
Depreciation		85	24	24	24	24	24	24	24	24	24
Loan balance	305	215	140	61	0	0	0	0	0	0	0

The result of CP introduction was analysed financially as follows:
If the recycling ratio reaches 70%, this investment can be judged as sufficient, because POT is 3.7 years. When the recycling ratio is 60%, POT is 5.8 years, which is considered as insufficient in profitability. Therefore, it is expected that the model factory increase the recycling ratio to 70% at least.

11.9 CP Benefit

It is thought that there is the following benefit for the model factory by installation of the new plant:

(1) After increasing operating load of the factory, the factory can decrease production cost by RM110,340 per year when 70% of treated wastewater is recycled.

(2) However, POT is 5.8 years, which is considered as an insufficient profitability when the recycling ratio is 60% as described above. Therefore, the model factory

must increase the recycling ratio to 70% at least.

(3) Through installation of the new plant, this factory will become a real model factory in the textile sub-sector in Malaysia from the viewpoints of city water consumption and wastewater discharge, and the following are also indirect benefits:

(a) Image up of the factory in the dyeing industry,

(b) Contribution to the conservation of natural resources,

(c) Contribution to the environmental preservation, and

(d) Getting encouragement for promoting the efforts of increasing productivity.

Calculation for the direct economic merit is possible, but calculation for the indirect merits is impossible. However, the latter seems to be larger than the former.

11.10 Recommendations

(1) Study on Common Facility for Water Supply and Wastewater Treatment

In Malaysia, city water is expensive and most of the textile factories are using river water. River water is used as process water after treatment such as neutralisation and filtering in each factory. Generally highly treated city water is more expensive than the industrial water which is treated at lower level. At present, however, there is no industrial water supply system in Malaysia; therefore it is recommended to study the installation of industrial water supply system from the economical and environmental viewpoint by the organisation in textile industry. it is also recommended to study the installation of common wastewater treatment facility in the area where many factories are discharging wastewater. Normally, the wastewater treatment fee in the common wastewater treatment facility is not cheap, but it is expected that each factory will make effort to improve the quantity and quality of discharging wastewater by introducing many kinds of CP equipment.

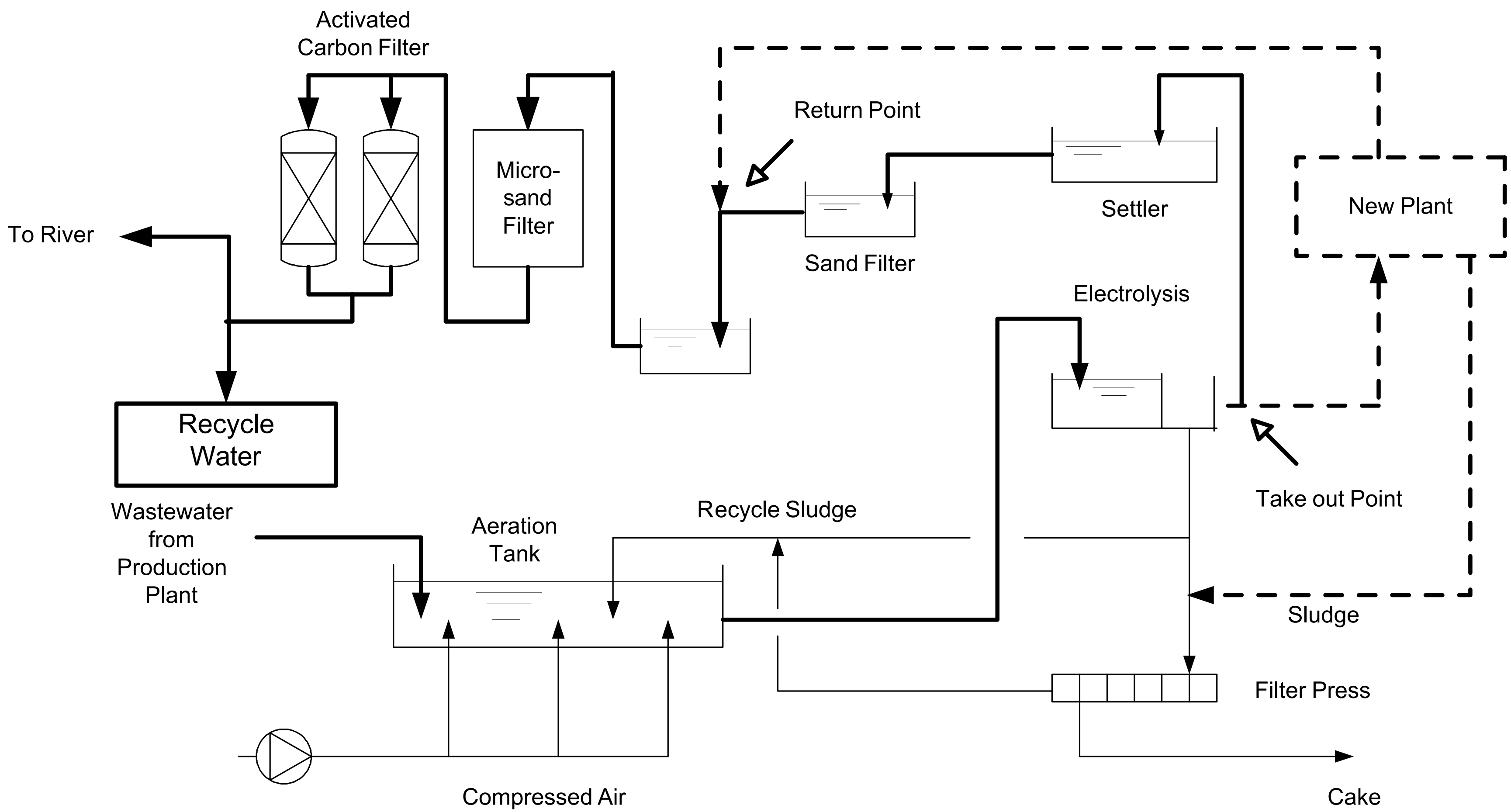

Figure 11-3 Process Flow Sheet for Wastewater Treatment Plant (Before CP Introduction)

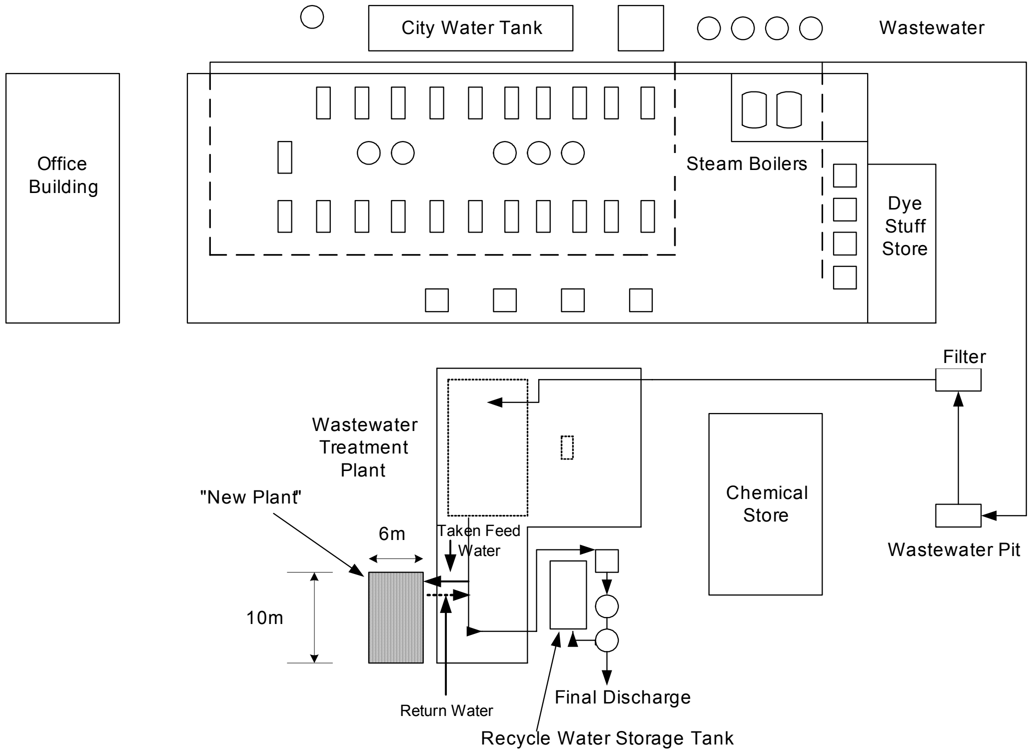

Figure 11-4 Factory Plot Plan (Location of New Plant)

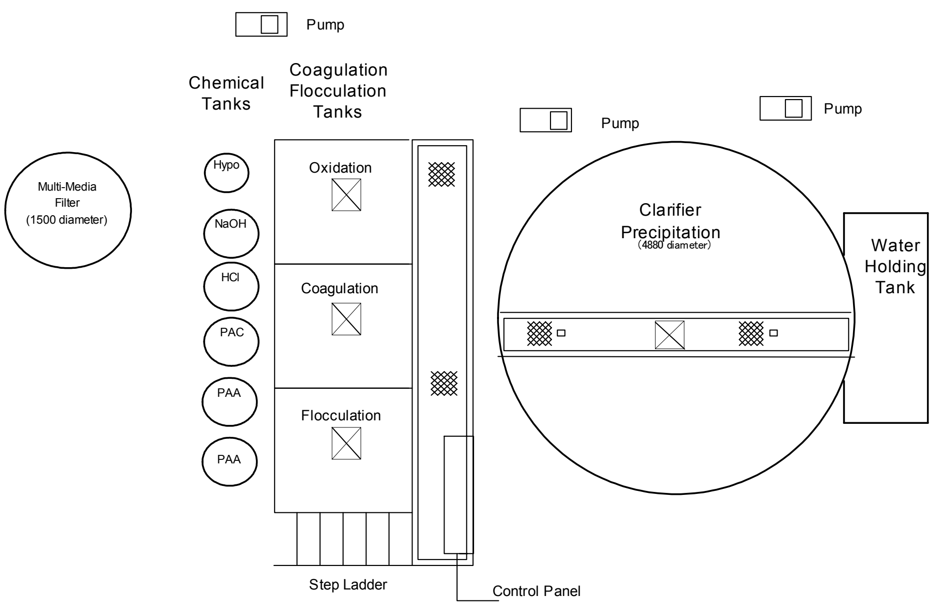

Figure 11-5 Plot Plan of New Wastewater Treatment Plant

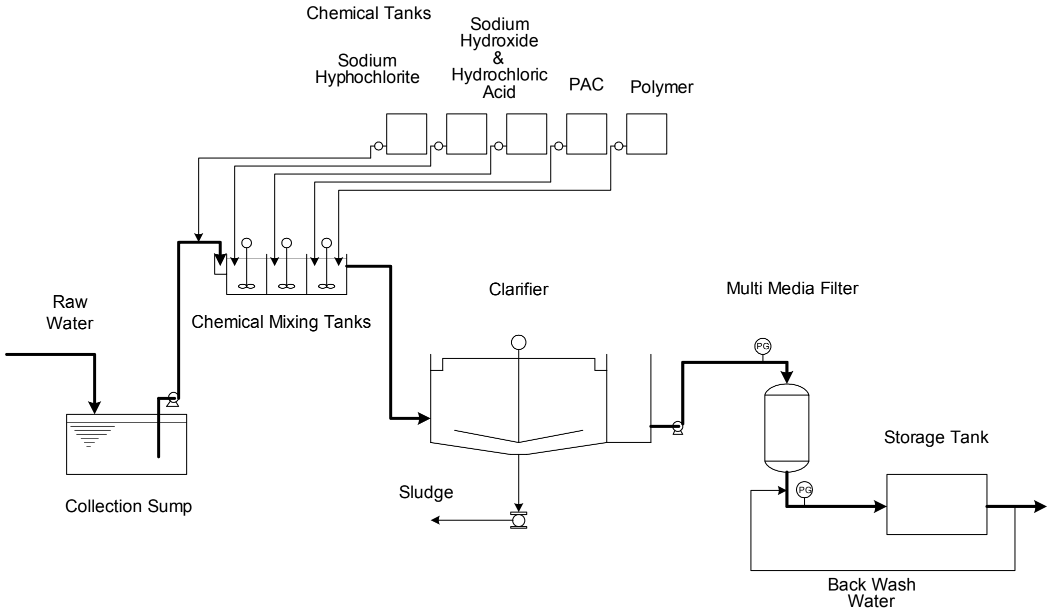

Figure 11-6 Process Flow Sheet for New Wastewater Treatment Plant

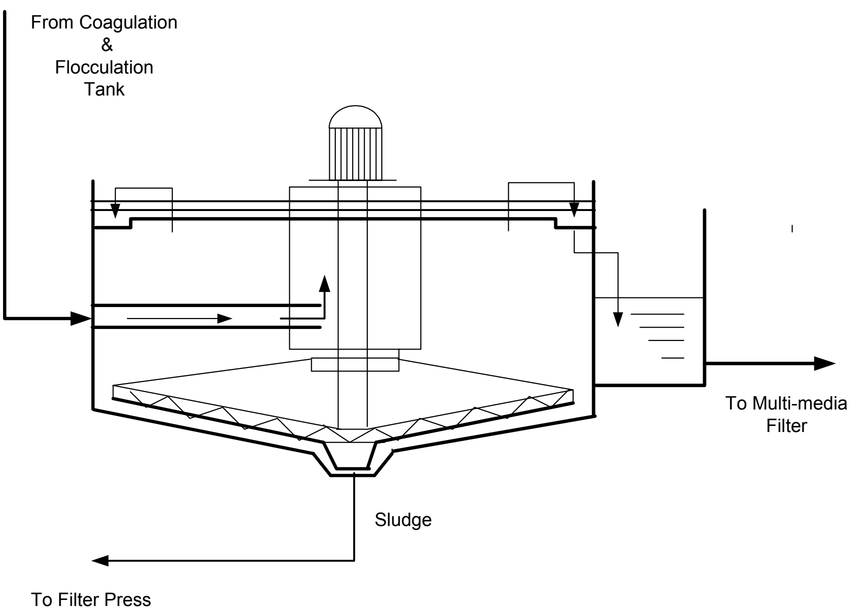

Figure 11-7 Outline Drawing of Clarifier

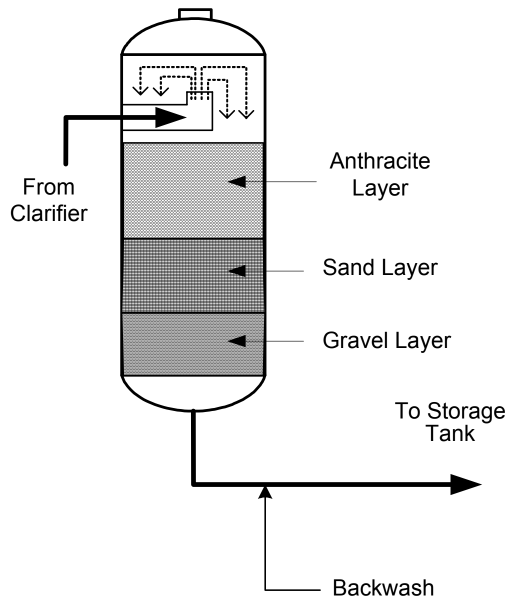

Figure 11-8 Outline Drawing of Multi-media Filter

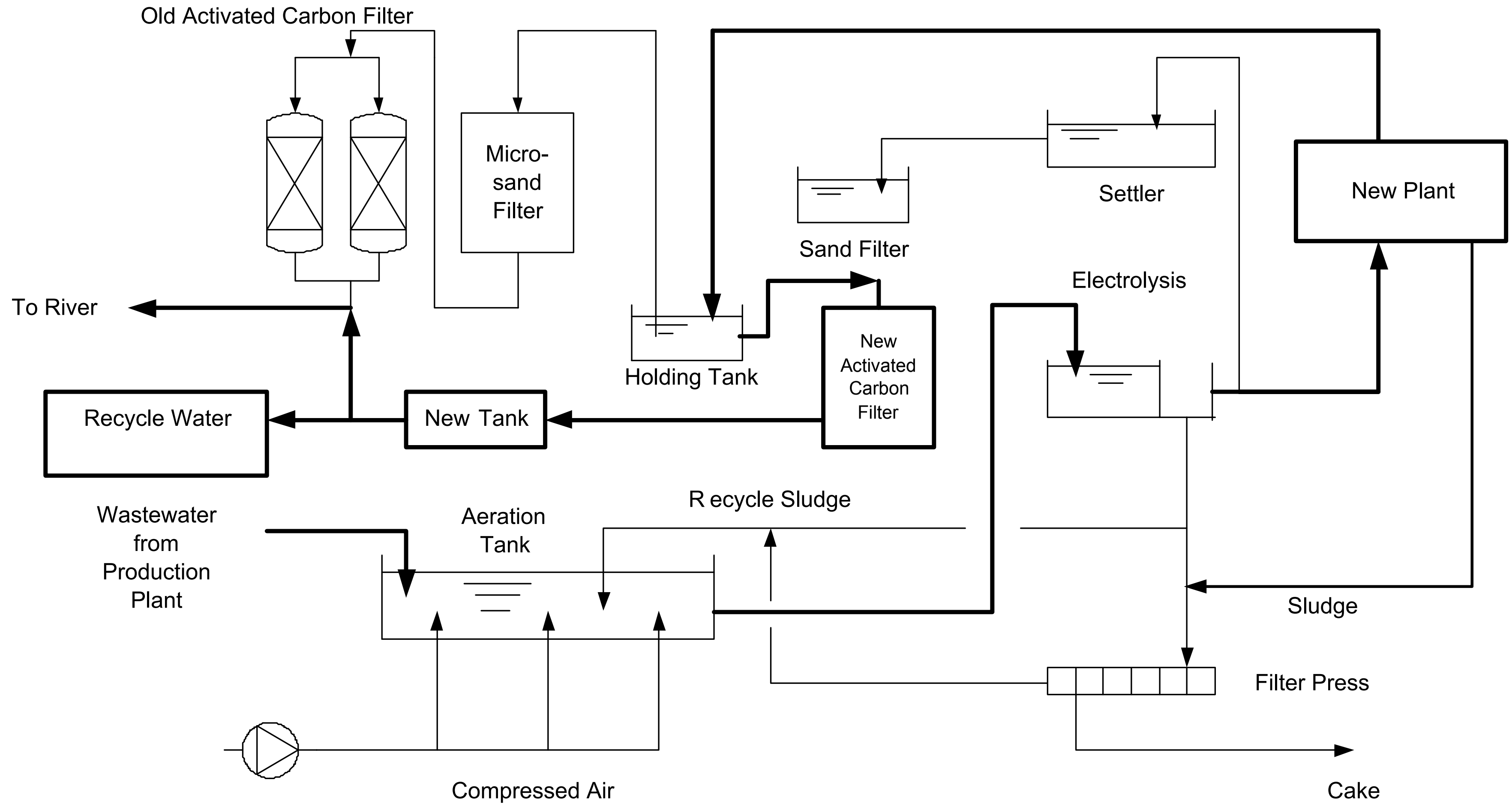

Figure 11-9 Process Flow Sheet for Wastewater Treatment Plant (After CP Introduction)

Table 11-10 Iron Ion Removal Process and Characteristics

Name of Process	Characteristics
a. Reverse osmosis (RO)	① Good for removing iron ion content ② Economically not so feasible and not effective for removing electrolyte
b. Ion Exchanger (IE)	① Good for removing iron ion content ② Economically not so feasible
c. Activated carbon adsorption	① Not effective for removing iron content
d. Chelating agent such as EDTA (Ethylene di-amine tetra-acetic acid) injection	① Not so effective (Tested at SIRIM laboratory)
e. Changing iron electrode from iron to aluminum at existing electrolysis Process	① No generation of iron ion, but it increases sludge material
f. Coagulation-flocculation	① Good for removing iron ion ② De-colouring is not enough

Table 11-11 Operational Standard for Chemical Injection

Tank No.	Unit	C1	C2	C3	C4	C5
Chemical name		NaClO	NaOH	PAC	Polymer	Polymer
Tank volume	Litre	100	200	200	1,800	1,800
Concentration of chemicals	%	10% liq.	50% liq.	18% liq.	Powder	Powder
Injection rate to feed water	mg/l	40	36	50	2	2
Preparation amount of chemicals	litre	100	200	200	18 kg	18 kg
Water amount	m^3	0	0	0	1.800	1.800
Concentration of chemicals	%	10	50	18	0.1	0.1

Attachment

Surveyed Factories for Selection of Model Factory

The outline of the surveyed factories is described below.

1. South Asia Textiles (M) Sdn. Bhd.

Refer to Section 11.2.

2. Berjaya Knitex Sdn. Bhd.

2.1 Present Status

(1) Observation of pollution control conditions

The wastewater and exhaust gas are the items specified in the pollution regulations. The COD value of wastewater at the point of discharge to the river exceeds the Malaysian standard B. It is recommended that the following items are studied.

a. Improvement of operational method at wastewater treatment system,
b. Reduction of wastewater generated from production process, and
c. Capacity expansion of wastewater treatment system.

The factory uses heavy oil as boiler fuel. The SO_2 and NOx concentration in boiler exhaust gas seems to observe the Malaysian standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel. The reduction of fuel oil consumption is important not only for SO_2 and NO_x reduction but also CO_2 reduction for the prevention of global warming.

(2) Waste Disposal, treatment and recycling

The sludge generated from the wastewater treatment plant is consigned to external company, Kualiti Alam Sdn. Bhd. on commissioning.

(3) Measures for Productivity Improvement

In order to cope with both yarn and fabric clients, the factory has both sewing and fabric dyeing machines.

2.2 CP Options

(1) Heat loss recovery from steam condensate

Reduction of heat loss through the reinforcement of insulation on steam piping could be one CP option. But the potential amount of recovered heat is too small to require implementation.

(2) Heat loss recovery from steam boiler

Heat recovery should be attempted by heat exchanging from exhaust flue gas to the in-take air of steam boiler. The Ungstrohm type heat exchanger is currently available in the market but economically not feasible in this size of small boiler.

(3) Quality of effluent water to the river

It is recommended that the capacity of the wastewater treatment plant is increased by adopting technology such as active sludge.

(4) Power factor improvement of electricity

Utilising sewing equipment, electricity consumption is relatively higher than standard dyeing houses doing solely dyeing work. As electricity is the most cost influential utility, the systematic analysis of the operating condition of electric equipment should be conducted for the application of advanced technologies such as power factor controllers, rotating speed controls and others. The electric system consists of receiving and distributing units, transformers, controlling panel, voltage regulators, cables and motors.

3. Sykt Perusahaan Fintex Sdn. Bhd.

3.1 Present Status

(1) Observation of pollution control conditions

The wastewater and exhaust gas are the items specified in the pollution regulations. The COD value of wastewater at the point of discharge to the river exceeds the Malaysian standard B. It is recommended that the following items are studied.

a. Improvement of operational method of wastewater treatment system,
b. Reduction of wastewater generated from production process, and
c. Capacity expansion of wastewater treatment system.

The factory uses heavy oil as boiler fuel. The SO_2 and NOx concentration in boiler exhaust gas seems to observe the Malaysian standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel.
The reduction of fuel oil consumption is important not only for SO_2 and NO_x reduction but also CO_2 reduction for preventing global warming.

(2) Waste Disposal, treatment and recycling

The sludge generated from the wastewater treatment plant is consigned to external company, Kualiti Alam Sdn. Bhd. on commissioning.

(3) Measures for Productivity Improvement

In order to cope with both yarn and fabric clients, the factory has both sewing and fabric dyeing machines.

3.2 CP Options

(1) Heat loss recovery from steam condensate at lower than 100 ℃

Although steam condensate temperatures higher than 100℃ is used as boiler feed water, steam condensate of temperatures lower than 100℃ is not used because of insufficient pressure. Installation cost for pressurising pump could not be offset when comparing to the expected amount of heat recovery.

(2) Heat loss recovery from steam boiler

Heat recovery should be tried by heat exchanging from exhaust flue gas to the in-take air of steam boiler. The Ungstrohm type heat exchanger is currently available in the market but economically not feasible in this size of small boiler.

(3) Improvement of quality of effluent water to the river

It is recommended that the capacity of the wastewater treatment plant is increased by adopting technology such as active sludge.

4. Sykt Koon Fuat Industries Sdn. Bhd.

4.1 Present Status

(1) Observation of pollution control conditions

The wastewater and exhaust gas are the objects specified in the pollution regulations. The COD value of wastewater at the point of discharge to the river exceeds the Malaysian standard B. It is recommended that the following items are studied.

a. Improvement of operational method of wastewater treatment system,
b. Reduction of wastewater generated from production process, and
c. Capacity expansion of wastewater treatment system.

The factory uses heavy oil as boiler fuel. The SO_2 and NOx concentration in boiler exhaust gas seems to observe the Malaysian standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel. The reduction of fuel oil consumption is important not only for SO_2 and NO_x reduction but also CO_2 reduction for preventing global warming

(2) Waste Disposal, treatment and recycling

The sludge generated from the wastewater treatment plant is consigned to external company, Kualiti Alam on commissioning.

(3) Measures for Productivity Improvement

Through introduction of a jet dyeing machine, the company could handle mass production and wide range of quality requirements.

4.2 CP Options

Through installation of steam condensate recovery equipment, it is expected that steam consumption could be reduced about 11 tons per day. Further economic study is required for implementation.

(2) Heat loss recovery from steam boiler

Heat recovery should be tried by heat exchanging from exhaust flue gas to the in-take air of the steam boiler. The Ungstrohm type heat exchanger is currently available in the market but economically not feasible in this size of small boiler.

(3) Improvement of quality of effluent water to the river

It is recommended that the capacity of the wastewater treatment plant is increased by adopting technology such as active sludge.

5. M.K.K. Industries Sdn. Bhd.

5.1 Present Status

(1) Observation of pollution control conditions

The wastewater and exhaust gas are the items specified in the pollution regulations. The COD value of wastewater at the point of discharged to the river exceeds the Malaysian standard B. It is recommended that the following items are studied.

a. Improvement of operational method of wastewater treatment system,
b. Reduction of wastewater generated from production process, and
c. Capacity expansion of wastewater treatment system.

The factory uses heavy oil as boiler fuel. The SO_2 and NOx concentration in boiler exhaust gas seems to observe the Malaysian standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel. The reduction of fuel oil is important not only for SO_2 and NO_x reduction but also CO_2 reduction for preventing global warming.

(2) Waste Disposal, treatment and recycling

The sludge generated from the wastewater treatment plant is consigned to external company, Kualiti Alam on commissioning.

(3) Measures for Productivity Improvement

In order to improve productivity, the introduction of fully automated and computer-controlled dyeing machines is under consideration. The company has a plan to conduct systematic education of operational staff in the near future. In conjunction with the installation of new dyeing equipment, the company is considering the reduction of the wastewater load of the dyeing process.

5.2 CP Options

(1) Reduction of heat loss by recovery of steam condensate

Through installation of steam condensate recovery equipment, it is expected that steam consumption could be reduced about 11 tons per day.

(2) Heat loss recovery from steam boiler

Heat recovery should be tried by heat exchanging from exhaust flue gas to the in-take air of steam boiler. The Ungstrohm type heat exchanger is currently available in the market but economically not feasible in this size of small boiler.

(3) Improvement of quality of effluent water to the river

It is recommended that the capacity of the wastewater treatment plant is increased by adopting technology such as active sludge

6. Samtex Industries Sdn. Bhd.

6.1 Present Status

(1) Observation of pollution control conditions

The wastewater and exhaust gas are the items specified in the pollution regulations. The COD value of wastewater at the point of discharged to the river exceeds the

Malaysian standard B. It is recommended that the following items are studied

a. Improvement of operational method of wastewater treatment system,

b. Reduction of wastewater generated from production process, and

c. Capacity expansion of wastewater treatment system.

The factory uses heavy oil as boiler fuel. The SO_2 and NOx concentration in boiler exhaust gas seems to observe the Malaysian standard, judging from good operational management and the utilisation of less sulfur and less nitrogen fuel. The reduction of fuel oil is important not only for SO_2 and NO_x reduction but also CO_2 reduction for preventing global warming.

(2) Waste Disposal, treatment and recycling

The sludge generated from the wastewater treatment plant is consigned to external company, Kualiti Alam on commissioning.

(3) Measures for Productivity Improvement

As both CT type dyeing machines (for cotton) and HT type dyeing machines (for polyester) are installed, it is possible to cater to various kinds of client requests such as cotton, polyester and nylon dyeing.

6.2 CP Options

(1) Heat loss recovery from steam condensate and warm water

Through installation of steam condensate recovery equipment, it is expected that steam consumption could be reduced up to 590 tons per year. Collection and analysis of data and study of expectations and costs of condensate tank, piping and equipment is required.

(2) Reduction of fuel consumption by reinforcement of insulator on steam piping

Reinforcement of insulation thickness from 30mm to 75mm (Japanese standard) would reduce the fuel consumption of 5,000 litres per year.

(3) Heat loss recovery from steam boiler

Heat recovery should be tried by heat exchanging from exhaust flue gas to the in-take air of steam boiler. The Ungstrohm type heat exchanger is currently available in the market but economically not feasible in this size of small boiler.

Demonstration Project for Cleaner Production
in Food Processing Sub-sector (Noodle Manufacturing Factory)

Model factory: South Asia Textiles (M) Sdn. Bhd.

Study tour (25 June 2002)

CP Equipment Overview

Chemical Dosing system


Clarifier Top-view


Multi-Media Filter
(at Supplier factory in October 2001)