

SHEN'S ART PRINTING CO. LTD. (Taiwan)



ABOUT THE COMPANY

Shen's Art Printing Co. Ltd. is a leading company in the field of cultural, commercial and art printing. Formed in 1977, Shen's has invested heavily in innovative color separation, plate making and electronic publishing system technology. A medium-scale company, it is located in To-Cheng City, Taipei County, has a staff of 180, a floor area of 5,300 m² and an annual turnover of some US\$ 10 million.

The company has an impressive record of environmental improvement programs. Prior to the implementation of its GP program, Shen's had already reduced pollution and improved energy efficiency by installing water recycling, temperature-control, dust filtration and air change systems. These technological innovations have been backed up by a strong environmental management regime. Shen's was awarded the ISO 14001 Environmental Management System Certification in 1996.

WHY GP?

INNOVATION

As a forward-thinking company, Shen's viewed GP as an excellent opportunity to develop new technical and management solutions to its business challenges. The company's GP goals included capitalizing on reductions in raw material and resource consumption to lower production costs, upgrade productivity and improve the work environment.

ENVIRONMENTAL EXCELLENCE

GP provides a company with an opportunity to not only comply with environmental regulations and standards but also to demonstrate that it is committed to continuous improvement and the pursuit of environmental excellence. Because of this, Shen's recognized that GP could help it improve its image and be a leader in its sector while also helping it open up new business opportunities abroad.

To implement GP, the company used the methodology described in the introductory chapter.

MAIN ISSUES

The plant baseline audit looked at all aspects of the company's production process. The audit included assessment, tests and analysis of waste water, material and energy inputs and outputs. It also investigated waste characteristics and efficiency/productivity issues. Shen's operations are divided into pre-press (preparation of art work and plate processing) and press processes. Shen uses both manual and electronic pre-press systems and employs offset lithography technology. The main stages of Shen's production process are shown in Fig. 1. The following issues were highlighted:



WASTE WATER

Manual pre-press film and plate making and processing operations were found to produce large quantities of waste water. The waste liquor from the platemaking process had a high chemical oxygen demand (COD) and high levels of dissolved silver. The press cleaning procedures also resulted in a major waste water stream containing residual ink.

GASEOUS WASTE

The press process produced volatile organic chemicals (VOCs), dust and acid gas. The major VOC emission came from the solvents used to wash and clean machinery such as the ink feeder and press.

SOLID WASTE

Solid wastes included waste plates, waste film, empty containers, waste ink and ink cans, spent rags and wastepaper.

INEFFICIENCIES

The plant's lighting, air conditioning, energy supply and management systems were found to be inefficient. Moreover, the company's contract with its power supplier was not optimally specified since the basic fee, which was not directly related to the company's daily power consumption, was calculated in such a way that the company might overpay a significant portion of the electricity bill.

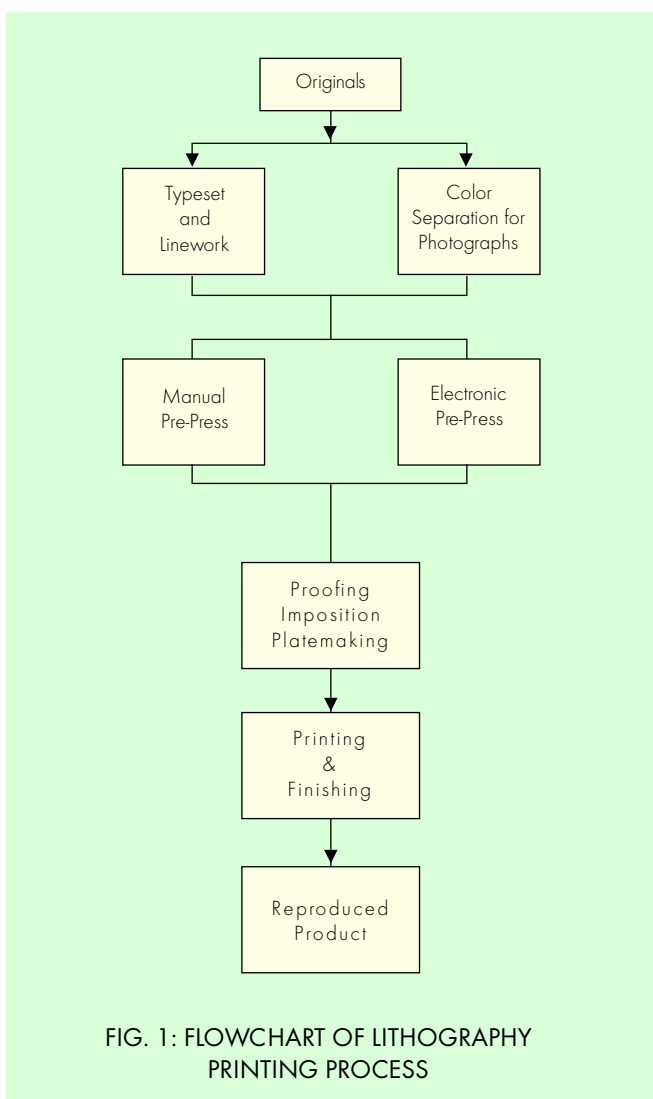


FIG. 1: FLOWCHART OF LITHOGRAPHY PRINTING PROCESS



GP SOLUTIONS

After studying the processes and operations and analyzing all technological and management options the GP team came up with the following main suggestions for improvements:

- Recover fixing silver from waste water.
- Recover residual ink and substitute solvent-based ink.
- Recover spent cleaning rags.
- Recycle packaging materials and containers.
- Implement film recovery, reduction and substitution.
- Improve energy conservation and efficiency.
- Eliminate mechanical noise.
- Phase out manual pre-press in favor of an electronic system.
- Reduce VOC emissions.
- Invest in innovative technology and research/development.
- Establish a unified industrial waste treatment system.

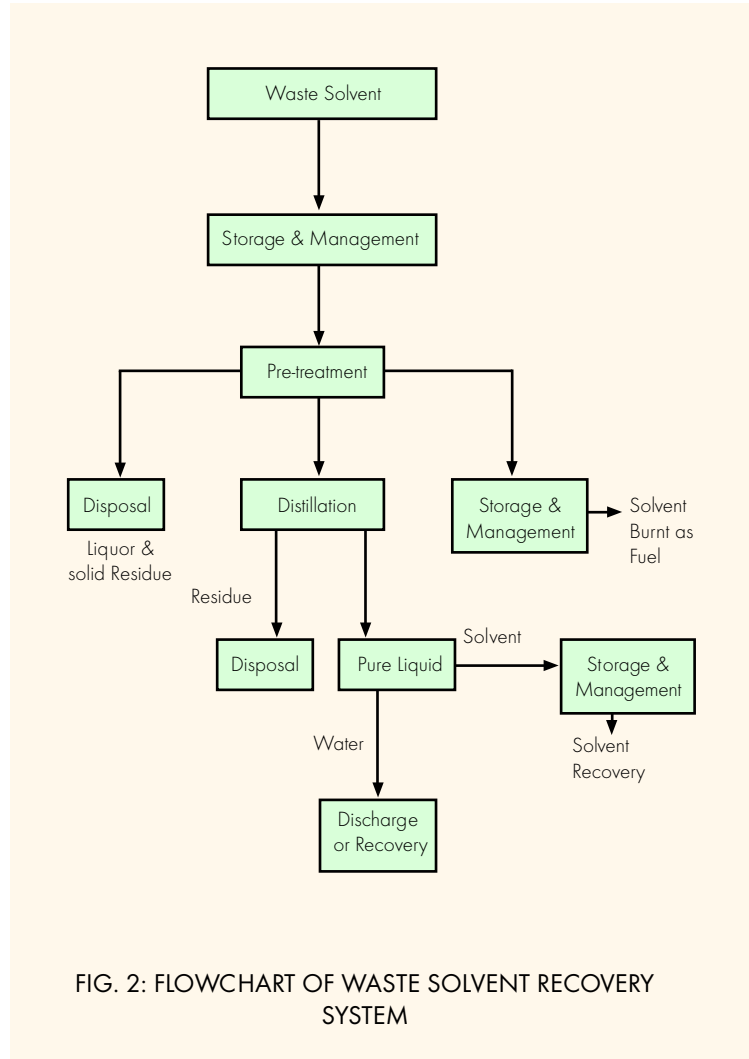


FIG. 2: FLOWCHART OF WASTE SOLVENT RECOVERY SYSTEM

GP IMPLEMENTATION

The options identified by the GP team were evaluated in terms of their environmental impact and technical and economic feasibility. Four were selected for immediate implementation and the rest were scheduled as long-term objectives. The following key improvements were implemented:

CHEMICAL RECOVERY

A system to recover silver from waste liquor by electrolysis was installed. This allows the silver to be re-used. The capital investment for this system totalled NT\$ 170,000 (US\$ 5,457), however it gives annual benefits (after running costs) of NT\$ 114,328 (US\$ 3,669). Savings include silver recovery of about 56 kg/year worth over NT\$ 124,000 (US\$ 3,980). This translates into a 18 month payback period.



A distillation system to recover waste solvent from the printing blanket and wiping rags was installed (see Fig. 2). The capital investment for this system was NT\$ 395,000 (US\$ 12,679), however it gives savings of NT\$ 306,000 (US\$ 9,822) per year due to a 75% solvent recovery rate. It also generates a NT\$ 3,056 (US\$ 98) annual reduction in wastewater treatment costs.

Given running costs of NT\$ 6,009 (US\$ 192), this translates into a total annual benefit of NT\$ 303,047 (US\$ 9,727) and a payback period of 16 months.



ENERGY EFFICIENCY

Plans to rationalize the use of energy were drawn up after a site evaluation by technical consultants from the Energy Technical Service Center of China. Implementation of the plans were estimated to give annual benefits of NT\$ 300,000 (US\$ 9,630).

PROCESS CHANGE

The phase out of the manual pre-press process was initiated. This involved the promotion of electronic working with all clients and is estimated to have reduced the company's film and chemical usage by two thirds (as compared with old manual methods). This translates into economic savings of about NT\$ 7.44 million (US\$ 238,824) per year. The transition to electronic publication systems has also brought improvements in working conditions and process management.

GP BENEFITS

The implementation of the four major GP options improved the environmental performance of Shen's factory in terms of its water and air pollution and its consumption of resources and energy.

ECONOMIC SAVINGS

The company has also enjoyed substantial economic benefits with annual benefits estimated to be NT\$ 8,150,000 (US\$ 261,615) in total.

CONCLUSIONS

The implementation of GP at Shen's showed how wide-ranging the environmental improvement possibilities are even in a progressive and technologically innovative company. It also demonstrated that the economic benefits of such improvement can be large and that payback periods need not be long-term.

Shen's plant represents a successful case study which demonstrates unequivocally to the printing sector that environmental protection and economic productivity can go hand in hand.



“Obtaining ISO certification and our research in minimization of waste are the results of the joint effort of our company and our customers in seeking excellence in the market.

By forming a team with our customers, Shen's Art will succeed in pioneering an approach which promises endless opportunities.”

Mr Hsi Chen
General Manager
Shen's Art Printing Co. Ltd.

Video available for this case study from:

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SHUI-HUA LEATHER INDUSTRIAL CO. LTD. (Taiwan)

ABOUT THE COMPANY

Shui-Hua Leather Industrial Co. Ltd. is one of the largest and most successful tanneries in Taiwan. It has been supplying fine quality leather since 1975 and Shui-Hua products are used by ‘household name’ manufacturers around the world.

Shui-Hua processes all types of leathers for shoe uppers, handbags, attaché cases and many other consumer goods. Its current plant comprises a 10 acre tannery located in Tainan Hsein, Taiwan, ROC. This employs over 200 workers and has a daily production run of some 2,000 pieces of Texas Steer hide — equivalent to about 9% of Taiwan’s total production.

The company has invested extensively in advanced machinery — its capital investments total some NT\$ 195 million (US\$ 6.25 million). Rigorous quality control based on the ISO 9002 standard, ensures high standards are maintained and contributes to annual sales of more than NT\$ 1 billion (US\$ 32.1 million).

WHY GP?

ENVIRONMENTAL IMPROVEMENT

The leather tanning industry in Taiwan is a significant source of pollution. In particular, waste water from the sector can contain strong alkalis, bio-wastes and high concentrations of heavy metals such as chromium. If not treated properly, this poses a significant risk to the environment and human health.

Increased international demand for good environmental performance and steadily tightening effluent standards



mean that the domestic industry must look for ways to reduce its pollution impact. However, about 78% of tanning in Taiwan is done by small or medium-sized enterprises. Such companies are hampered by outmoded technology, financial constraints, land restrictions and other problems and are unwilling to invest in projects related to environmental improvement.

By implementing GP, Shui-Hua aimed to show that good internal management and waste reduction measures can effectively prevent pollution and that such solutions can bring production and economic benefits.

To implement GP, the company used the methodology described in the introductory chapter.

MAIN PROBLEMS

Shui-Hua's manufacturing process (see Fig. 1) begins with the batch treatment of raw hides by washing, soaking and liming them in a rotating drum. The wetted hides are then treated to remove residual meat from the skin — a process known as 'fleshing'. Defleshed hides are transferred onto a second rotating drum for delimiting and bating, pickling, tanning and wringing. After splitting and shaving, the hides are loaded onto a third rotating drum for dyeing and the fat liquor dewatering process. The finishing stage includes drying, coating, conditioning, milling, buffing and plating. The audit of this process revealed the following key issues:

WASTE WATER

Shui-Hua generates about 1,000 m³ of waste water a day. This includes periodic high concentrations from the discharge of batch drums and a continuous effluent stream from cleaning processes.



WASTEWATER	POLLUTION SOURCE
Pre-soaking, Soaking, Liming	First Rotating Drum: The wastewater after the pre-soaking & liming treatment process
Chrome Tan	Second Rotating Drum: The wastewater after the pickling & tanning treatment process
Coloring, Fatliquoring	Third Rotating Drum: The wastewater after the coloring & fatliquoring process
Drying, Coating	In addition to above three sources

The waste water was found to contain spent soaking, tanning and chromic acid solutions and other related acidic/alkaline solutions. It carried high concentrations of COD, suspended solids, salt, sulfide, chromium and color. Furthermore, it contained various toxic substances that inhibit the growth of microorganisms, thus complicating downstream waste water treatment.

To cope with this high load of pollution the company has a waste water treatment facility with a capacity of 1,500 tons/day. However it was clear that there was considerable scope for waste reduction at source and for improvements in water use efficiency.

SOLID WASTE

It was found that about a third of all raw materials were discarded during the production process and that about nine tons of solid waste was generated per day. This waste stream included waste hair from the soaking and liming treatment, waste flesh and other bio-wastes. 15 tons of sludge per day was also produced by the wastewater treatment process.

WASTE GAS

It was found that the coating and other finishing operations resulted in the emission of volatile organic compounds (VOCs). Some of these vapors had a relatively high toxicity. Chemical accidents and spills were also highlighted as potential sources of air pollution that could be harmful to human health and the environment. Odour — from the decomposition of organic matter and sulfide emissions from wastewater — was also a problem.

GP IMPLEMENTATION AND BENEFITS

Experts from Taiwan and Japan reviewed the production process of the Shui-Hua site and developed eight main GP improvement options. These were implemented within the framework of an ISO 14001 environmental management system. This strategy has delivered a number of significant environmental and economic benefits. The improvement options and associated benefits were:



PROCESS IMPROVEMENT.

The 'hair save' process was introduced. This involved a change in the composition of chemicals used in the soaking and liming processes so that hairs are removed and collected intact rather than dissolved. This has reduced the waste water pollution load and treatment costs and has allowed a higher price to be charged for the finished product. Although it entailed additional chemical and solid waste treatment costs, overall it has given substantial savings of over NT\$ 72 million/year (US\$ 2.3 million). As the improvements cost NT\$ 1.5 million (US\$ 48,150), the saving translates into payback period of just a quarter of a month.

IMPROVED HOUSEKEEPING

A systematic approach was applied to the improvement of day-to-day operations. This included the implementation of periodic waste audits and improvements in operating procedures and equipment maintenance. For example, good operational management was implemented in the spray and coating operations. This change included keeping the spraying area enclosed, improving equipment maintenance and enhancing ventilation. These measures significantly reduced VOC emissions.

SEPARATION OF WASTE WATER STREAMS

Waste water was segregated into three different streams: soaking, coloring and fat liquoring waste water; pickling and tanning waste water (containing chrome) and; lime and de-lime waste water (containing sulfate). This allowed specific treatment techniques to be applied to each stream so making overall waste treatment more effective and efficient.

RECOVERY OF CHROME

After analyzing ways to reduce the amount of chromium in the waste water, it was found that a chrome recovery system was less cost-effective than the alternative high fixation process. The company implemented such a process using techniques such as short float, increased temperature and basification. This reduced the amount of chrome in the wastewater from 3,000-4,000 mg/l to 1,520-2,260 mg/l.





DESALINATION

A patting machine was installed to shake off the salt from hanging hides. This reduced the sodium chloride content in the waste water and so improved subsequent biological treatment.

RESOURCE RECOVERY

Every effort was made to retrieve waste materials for re-use. For example: shavings and trimmings were sent to a fertilizer manufacturer and fleshings were sent to a soap plant for the extraction of tallow and grease. This is estimated to have saved about NT\$ 660,000 (US\$ 21,186) a year in disposal costs.

RATIONALIZATION OF WATER USAGE

Water consumption was rationalized and reduced through the installation of meters and stop valves. Currently the water consumption efficiency of Shui Hua's factory is about 80% of the average figure for Japanese leather tanneries. Potential savings of another 20% are thought possible. This type of improvement could result in savings of about NT\$ 1.55 million (US\$ 50,000).



CONCLUSION

Due to the small scale of most leather production companies and the significant pollution problems they face, it is vital that any environmental improvements are cost effective. GP implementation in Shui-Hua has demonstrated that this can be the case and that waste minimization linked to good environmental management provides a workable, profitable and effective solution.

The challenge now remains to promulgate these findings to the leather tanning industry at large. This is a problem given the fact that many artisans employed in the industry have gained their skills from experience and generally lack understanding of the concept of industrial safety, environmental protection and waste minimization. However, it is clear that, given escalating environmental awareness and global competition, owners of leather tanning plants will have little choice but to solve their pollution problems or go out of business. As Shui-Hua has shown, GP offers them a way forward.

"From this experience, I personally believe that implementing Green Productivity methodology is the best way to reduce the environmental burden of an organisation and at the same time improve its productivity."

Mr Ching-Tsung Cheng
GP Demonstration
Project Manager

Video available for this case study from:

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SOLASIA ENERGY DEVELOPMENT CO. LTD. (Taiwan)

ABOUT THE COMPANY

Solasia Energy Development Co. Ltd. is one of Taiwan’s leading solar energy equipment manufacturers. The company produces over 3,500 solar collectors (approx. 7,000 m²) a month and supplies the majority of these to ten down-stream enterprises for further processing. Solasia was originally founded in Fung Yuan City, Taichung County and moved to its present site in Senkung in 1987. Committed to innovation and quality, the company has invested heavily in automated machinery, has a staff of 15 and achieves annual sales of some NT\$ 42 million (US\$ 1.3 million).

Solasia has a long-standing commitment to environmental excellence and works within the ISO 14001 environmental management framework to ensure continual improvement. Prior to its implementation of GP, Solasia had already made a significant investment in environmental technology including waste water treatment equipment. It further ensures cleanliness and efficiency through the promotion of the 5S movement.

To implement GP, the company used the methodology described in the introductory chapter.

WHY GP?

ENVIRONMENTAL EXCELLENCE

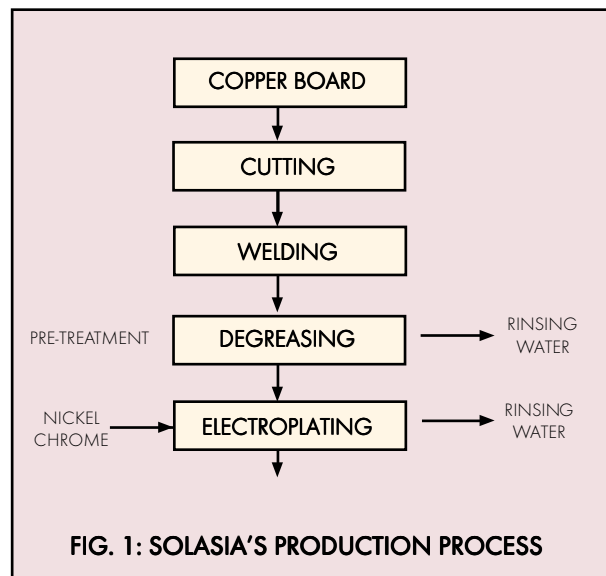
The solar energy industry plays a pivotal role in both the conservation of the world’s limited fossil-fuel resources and the



prevention of pollution. However, the industry itself can cause serious environmental problems. In particular, the electroplating of black chrome in the solar collector manufacturing process generates waste water with a high heavy metal content. This can be dangerous to the environment if not properly treated.

By embracing GP, Solasia hoped that it could demonstrate to other small and medium scale manufacturers in its sector that such issues could be dealt with in a financially-sustainable manner. In this way it hoped to show that the solar industry's good environmental credentials can extend from cradle to grave.

MAIN ISSUES



The basic raw materials of solar collectors are copper plates and tubes. The manufacturing process involves the following main steps (see Fig. 1):

1. Cutting of the copper board.
2. Welding of copper board to form the basic structure.
3. Pretreatment — to degrease the basic structure.
4. Electroplating the structure with nickel and chrome. Nickel is used as a protection measure. Chrome is the solar collecting medium.

The baseline study of Solasia's production facilities looked at the main inputs and outputs of the manufacturing process and investigated the existing environmental protection measures the company has implemented. Its key findings were:

- The factory has installed an electrolysis tank to recover nickel and an evaporator to recover chrome. It was found that the 'fluidized bed' electrolytic facility was not operating at optimal efficiency because of electrical design problems.
- The most significant air emissions found in Solasia's operations were tin vapors released during the molding process. A scrubber had been installed to treat these vapors.
- Noise was a problem, with welding noise highlighted as a hazard.
- Solid waste included transportation packaging, copper residue, defective pieces from the welding process, plastic coil and sludge.
- Waste water included degreased rinsing water, acid-neutralized rinsing water and nickel electroplating rinsing water. It was found that water use minimization/recycling was not well implemented and that better technology was needed to address this problem.



- The air knife mechanism used to recycle degreasing liquid created waste water problems and shortened the life of the degreasing dose.

GP SOLUTIONS

Assessment of Solasia's production process showed that, although Solasia had implemented environmental improvement measures for some years with good results, environmental monitoring, management and technology could be improved. With the help of experts from Japan, the Solasia GP team outlined nine key potential improvements. These were:

- Treatment of scattered solid waste in the copper cutting area.
- Labeling of the copper cutting working area.
- Minimization and treatment of vapor emissions from tin welding.
- Control and management of raw materials.
- Reduction in exposure to noise for welding operators.
- Planning of emergency response measures and establishment of Material Safety Data Sheets for hazardous material.
- Reduction in the amount of discharged nickel.
- Recycling of degreasing liquid.
- Recycling of rinsing water.

GP IMPLEMENTATION/BENEFITS

Solasia implemented the options developed in its GP program with good results. The most easily quantifiable environmental and economic benefits of this work are:

REDUCTION IN AMOUNT OF DISCHARGED NICKEL.

The electrical system of Solasia's nickel recycling system was modified, this successfully reduced the load on the plant's waste water treatment facility and increased the nickel recovery from 68.3% to 80% (equivalent to 794 kg). The modified equipment had an operating cost of NT\$ 2,000 (US\$ 64) a year and saved over NT\$ 238,200 (US\$ 7,646) in chemical costs (Ni costs NT\$ 300/kg (US\$ 9.62/kg)). Net benefits therefore totaled NT\$ 236,200 (US\$ 7,582) per year.

RECYCLING OF DEGREASING LIQUID.

The degreasing liquid recycling system was modified with the installation of a simple degreasing filter. This cost NT\$ 52,000 (US\$ 3,980) to install and had maintenance/operational costs of NT\$ 12,000 (US\$385) a year. However, it prolongs the life of the degreasing dose by an additional four years, resulting in savings of some NT\$ 2 million (US\$ 64,200). Net benefits are therefore NT\$ 1.98 million (US\$ 63,814) per year.

RECYCLING OF RINSING WATER.

Water recycling facilities were improved with the installation of an ion exchange tower, which allowed treated water to be re-used in the production process. This cost NT\$ 515,000 (US\$ 16,531) to install and NT\$ 30,000 (US\$ 963) a year to run and maintain. It reduced water consumption by 15m³/day and resulted in savings of NT\$ 69,300 (US\$ 2,224) (15m³/day x 330 working day/year x NT\$ 7/m³). Net benefits are therefore NT\$ 39,300 (US\$ 1,261) per year.

The annual benefit of GP project was therefore approximately NT\$ 2,250,000 (US\$ 72,225) in total.



CONCLUSION

The GP demonstration project at Solasia shows that improvements in resource usage and waste minimization are technologically and financially feasible in the solar collector manufacturing process. In fact the program results indicate that this sector could achieve a state of zero discharge of key pollutants if all possible technological and management improvements are made. In particular the project shows that a key environmental problem — waste water from electroplating — can be dealt with in an economically profitable way.

In terms of the implementation of such a scheme, Solasia's experiences highlighted the importance of consultation with experts and the need for 'experience exchange' within sectors. It also showed just how important committed management is to the achievement of effective environmental solutions.

“In executing this program, we have minimized waste generation in our production process through technology change and we are willing to share our experience with other APO members.”

**Mr Chang
General Manager
Solasia**

Video available for this case study from:

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KWAN KEE ELECTROLY DYEING FACTORY (HongKong)

ABOUT THE COMPANY

The **Kwan Kee Electroly Dyeing Factory** is located in a multi-story industrial building in the Tsuen Wan industrial area to the south west of Hong Kong's Kowloon peninsula. The factory undertakes anodizing and dyeing of aluminium articles such as apparel accessories and electronic components. It has 13 staff and a production area of about 50 m².

WHY GP?

DEMONSTRATION

Kwan Kee worked with the Hong Kong Productivity Council (HKPC) to implement GP in its factory. By establishing a demonstration site in a small, local establishment, the project partners aimed to motivate other factories to adopt GP as a business strategy to achieve environmental and productivity improvements. It is hoped that the experience gained at the factory can provide a reference and example for other factories that have not yet defined appropriate environmental strategies.



ENVIRONMENTAL IMPROVEMENT

The majority of the processes carried out in the Kwan Kee factory are 'wet' in nature and produce many different types of wastes such as acidic fumes, acidic waste water, dyeing wastes etc. If these wastes are not carefully dealt with they can pose health risks to workers and create problems of non-compliance with environmental regulations. It was hoped that GP would provide a cost-effective approach to the avoidance of such environmental problems.

To implement GP, the company used the methodology described in the introductory chapter.

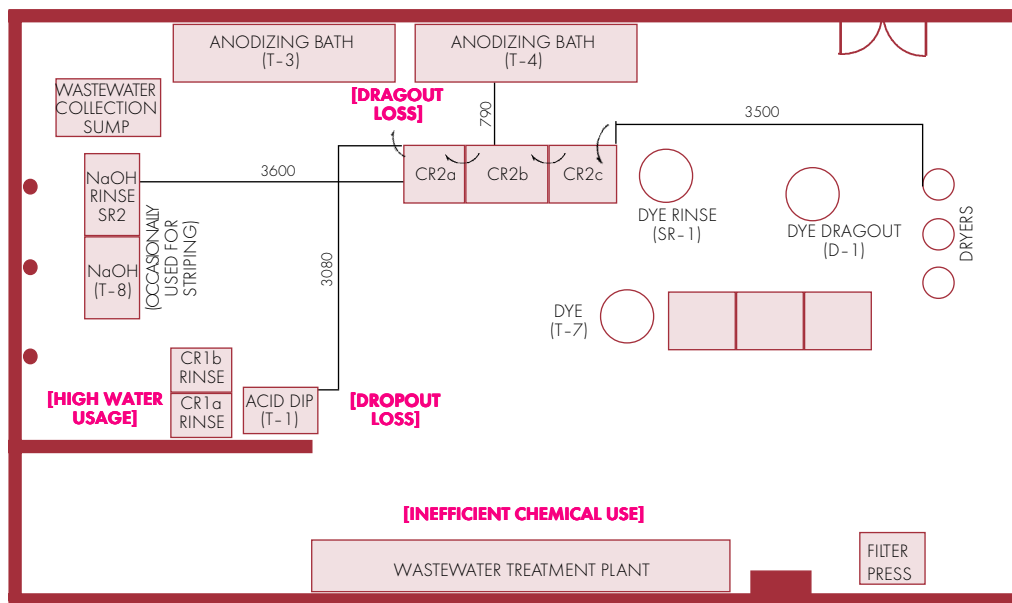


Fig 1: Eco-map of Plant Layout

MAIN ISSUES

A preliminary review of Kwan Kee's factory showed that the operating sequence consisted of the following main steps:

- Acid dipping
- Anodizing
- Dyeing/Coloring
- Drying
- Packaging

The waste audit — comprising field visits, inspection and sampling and analysis — identified a number of pollution issues at each stage of the production process. In particular, there was excessive drag-out loss of acid chemical solutions as products were treated in the acid dipping and anodizing areas. It was found that 75% of all acid loss occurred in the acid dip area. This was due to insufficient drain time being allowed after the parts had emerged from the tank.

The audit also found that rinse water usage was excessive. This was due to rinses running unattended during idle times in both the acid dip and anodizing areas and to the inappropriate design and poor maintenance of the rinsing tanks. For example the dyeing rinse only used a single-rinse tank which was considered inefficient in terms of water use.



The layout and design of the factory was also found to be non-optimal (see Fig. 1). In particular, the layout of the dyeing/coloring area required excessive movement back-and-forth between tanks. In addition, the floor operations were generally wet posing safety risks to workers.

At the company's pollution control facilities, maintenance was poor and the treatment chemicals were used inefficiently. The results of sample analysis revealed a high aluminium content in the treated effluent. After a detailed investigation it was found that this was due to inadequate flocculation. This resulted in large amounts of solids carrying over in the final discharge to the sewer.



GP SOLUTIONS

Based on the findings of the waste audit a number of targeted waste reduction measures were identified. Prior to finalization, all measures were discussed thoroughly and agreed with relevant personnel. This was to ensure that the recommendations were both compatible with conditions in the factory and were acceptable to the staff who would implement them. The following key changes were implemented:

REDUCING CHEMICAL LOSS

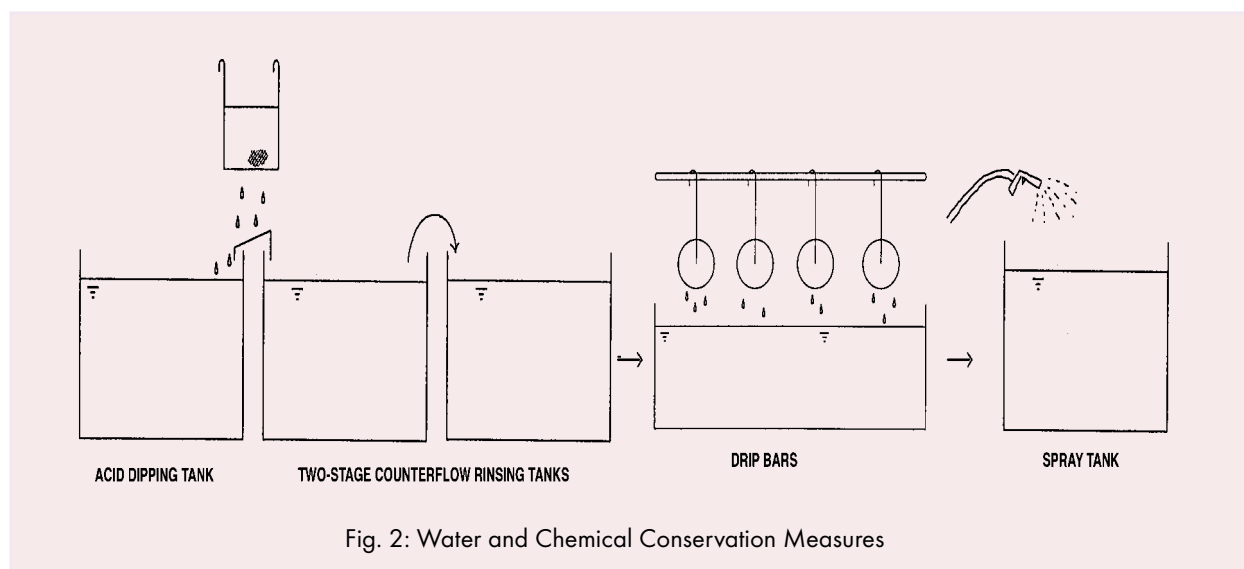
To increase production efficiency and reduce the amount of chemicals lost due to product drag-out, stainless steel drain boards were fixed between the acid bath and the rinse tanks in the acid dipping area and drip bars were installed above the anodizing baths (see fig. 2).



WATER CONSERVATION

Water conservation was achieved by constructing multi-stage counterflow rinsing tanks in both the acid dipping and anodizing areas (see fig. 2). The addition of water to both areas was controlled by installing a flow restrictor and a valve — allowing immediate water cut off in idle periods.

A spray gun mechanism and rinsing tray was installed in the dyeing area so that rinsing after dyeing could be performed. The tray allowed waste water to be collected in a sump.



POLLUTION REDUCTION

The shop floor was renovated to keep it dry and waste water sources were connected through pumps to a sump. This minimized the safety and health risks to workers. Rearrangement of the process tanks and chemical storage areas also reduced inherent safety hazards.

Operation and maintenance procedures were devised to optimize the operation of the pollution control facility and to conserve chemicals. These included a systematization of the operation of the air scrubbing system and waste water treatment system, along with a rationalization of troubleshooting and maintenance procedures.



GP IMPLEMENTATION/BENEFITS

The main benefits of the GP program at Kwan Kee's factory were chemical cost savings due to reduced drag-out loss in the acid dipping and anodizing areas, reduced rinsing water consumption and reduced volumetric loading of the waste treatment plant.

MATERIAL SAVINGS

The following specific benefits were gained:

- Consumption of nitric and sulphuric acid was reduced by 16%.
- Consumption of phosphoric acid was reduced by 17%.
- Consumption of polymer for the treatment plant was reduced by 27%.
- Consumption of caustic soda was reduced by 28%.
- Water consumption was reduced by 15%.

Net annual savings on chemicals was HK\$ 40,176 (US\$ 5,153) and on water was HK\$ 4,217 (US\$ 541).

CONCLUSION

This project showed that optimizing both waste reduction measures and the functioning of pollution control measures can bring economic and productivity benefits to the dyeing sector. It should be noted, however, that the GP options adopted by the factory were only those that were considered as priorities and were in no way comprehensive. To further improve its environmental performance the company is now using on-going reviews and assessments to identify where new improvements can be made.

“Despite an initial capital outlay, we found that the savings produced by the GP program made the system profitable.

We found that we can reduce both costs and pollution and anticipate that we can earn back the investment capital within one to two years.”

**Mr Andy Yau
Director
Kwan Kee Electroly
Dyeing Fty. Ltd.**



Video available for this case study from:

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DINTEX DYECHEM LTD. (India)



ABOUT THE COMPANY

Dintex Dyechem Ltd. is located in the Vatva Industrial Estate in Ahmedabad in Gujarat State, India. Its main products are dye intermediates such as vinyl sulfone, 6-Nitro, 1,2,4 acid and SPMP as well as reactive, acid and direct dyes. It is a medium sized company that has about 225 employees and a turnover of some 200 million rupees (US\$ 4,464,200).

WHY GP?

BUSINESS SUSTAINABILITY

The Indian dyestuff industry has a poor environmental performance record. Hundreds of factories in the sector have been closed in recent years for pollution infringements. Dyestuff companies now face the challenge of improving their performance to respond to both tightening regulatory enforcement and the demands of an international market that requires good environmental practice. By implementing GP, Dintex hoped that it could both improve its own performance and demonstrate to the rest of the Indian dyestuff industry that improvements are technically and economically feasible.

PRODUCT IMPROVEMENT

The GP demonstration project at Dintex Dyechem focused on the production of vinyl sulphone. This chemical is one of the major dye intermediates exported to developed countries. It generates a revenue of US\$ 64 million a year for India. However, manufacturers are facing acute environmental problems associated with vinyl sulphone production. Dintex hoped that a GP approach would help it to resolve this challenge.

To implement GP, the company used the methodology described in the introductory chapter.

MAIN ISSUES

Vinyl sulfone is produced in a batch process that takes about five days to complete. The four major stages in the production process are sulfonation, reduction, condensation and esterification. Equipment includes boiler and chilling plant and a thermic fluid heater.

A breakdown of the key stages and main inputs and outputs are illustrated in Fig. 1. The review of Dintex's manufacturing process highlighted the following main issues:

- The plant's electrical systems were generally under-loaded and not operating at optimal efficiency. Its steam distribution system was poorly maintained and leaky and its refrigeration system was inefficient.
- The plant's waste water treatment system — which comprises a neutralization tank, Neutch filter and clariflocculator and aeration, sedimentation and polishing tanks — was not adequate for the entire pollution load generated by the factory and needed to be modified.
- The plant was generating over 18.6 m³ of waste water per tonne of vinyl sulphone produced; 80kg of solid waste was generated per batch of vinyl sulfone (this comprised the impurities from the sodium bisulfite and insoluble matter present in the ice used in the production process). Gaseous emissions included HCl gas from the sulfonator, particulate emissions from the flash dryer and flue gases from the boiler.
- The plant's pollution outputs, inefficiencies and losses were attributed to:
 - Poor raw material quality (eg. impure sodium bisulphide and ice) and improper storage.
 - Poor training, housekeeping, operational and maintenance negligence, manual quantity estimation and poor monitoring.
 - Inadequate technology (eg. lack of hood on dumping vessel; inadequate HCl recovery system) and poor process and equipment design.

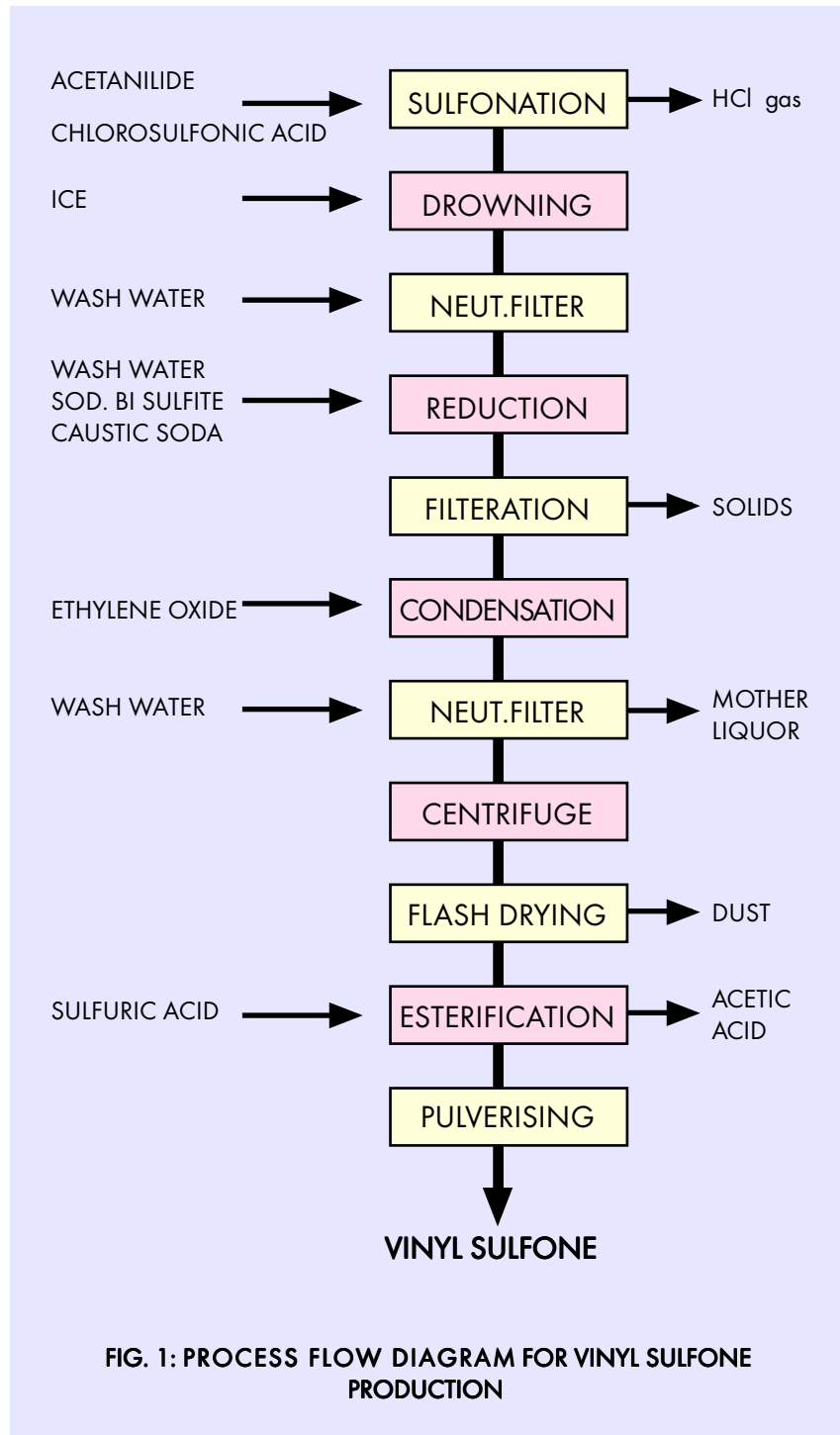


FIG. 1: PROCESS FLOW DIAGRAM FOR VINYL SULFONE PRODUCTION

GP SOLUTIONS/IMPLEMENTATION

As a result of the process review 66 potential improvements were highlighted. 36 were found to be technically and economically feasible, although half of these needed trials or laboratory studies before they could be implemented.

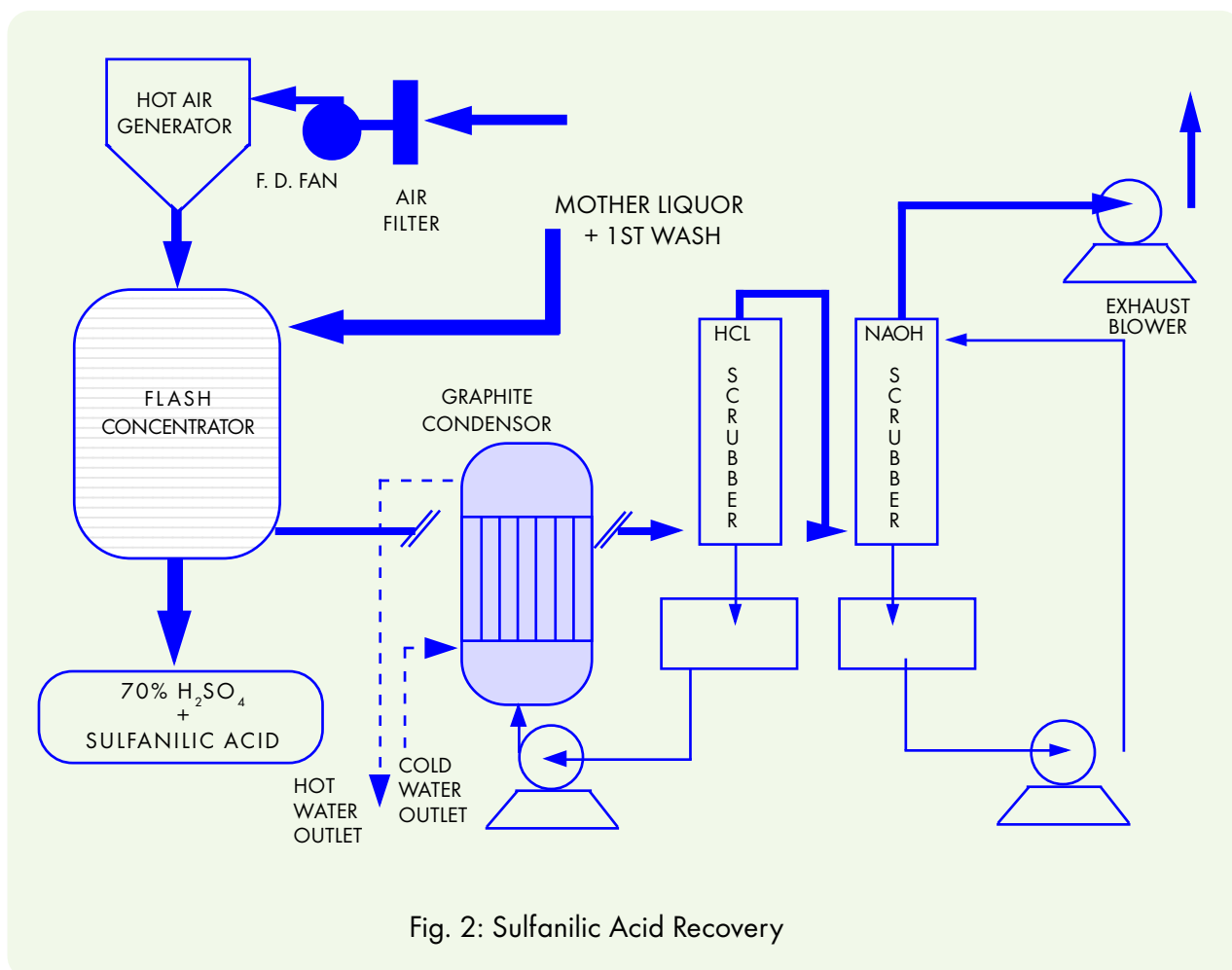


Fig. 2: Sulfanilic Acid Recovery

A number of different pollution treatment schemes were also analyzed, however it was found that treatment was not economically feasible and would generate large quantities of hazardous solid waste which would itself pose handling and disposal problems. Instead it was found that in-process pollution reduction and resource recovery represented the best options.

The improvements implemented included:

- Enhanced housekeeping, maintenance and monitoring. For example, the factory's steam distribution system was insulated and better process controls, such as temperature monitoring devices, installed.
- Pollution reduction through the retrieval and recycling of resources from waste. For example, sulfanilic acid was recovered from the mother liquor and salt from waste liquor (see fig. 2). Acidic mother liquor was retrieved for subsequent use in alum production in the paper industry.
- New technology development: For example, the HCl scrubber design was modified by installing a packed-bed type secondary stage to improve HCl recovery. The cake washing mechanism was also improved to reduce the amount of wash water needed.



BENEFITS OF GP

The implementation of the improvements outlined above generated substantial environmental and economic benefits. These included:

MATERIAL SAVINGS

Resource recovery per batch:

- 224 kg HCl.
- 200 kg sulfanilic acid.
- 8,800 kg acid.
- 7,200 kg of salts.
- 82 kg condensation product (equivalent to about 100 kg of vinyl sulfone).

ECONOMIC SAVINGS

This resulted in savings of over Rs.16 million (US\$ 357,136) a year — from an initial investment of some Rs 17 million (US\$379,457).

CONCLUSION

The Dintex GP project showed that a pollution prevention approach to environmental improvement can give significant benefits both in terms of production efficiency and profitability. The GP survey made it clear that the waste generated by dyestuff manufacturing requires complex and expensive treatment that produces many problems of its own. It also made it apparent that many of the outputs of the manufacturing process can be reused and thus represent a resource and income stream. In the highly competitive world dyestuffs market, Dintex's GP team concluded that any company that reduces its pollution load through a systematic program of pollution prevention and resource recovery will gain a substantial competitive edge.

“After implementing all the suggestions generated by the GP program, we will be able to meet the relevant regulatory standards. This was not possible earlier.

Now we are also getting wealth from the waste. In this way we are marching towards Green Productivity.”

**Mr. Dinesh S. Shah
Managing Director
Dintex Dyechem Ltd**

Video available for this case study from:

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SPINDEX INDUSTRIES LTD. (Singapore)

ABOUT THE COMPANY

Founded in 1981 as a one-man, one-machine company, Spindex Industries Ltd. has grown into a regional group with subsidiaries in Malaysia and China. The Group employs 450 staff, with 150 at the Singapore plant. Spindex produces precision-machined components and sub-assemblies. These are used in a diverse range of office automation products, computer peripherals, consumer electronics, medical equipment, domestic appliances and automotive and telecommunication applications.

Spindex started its environmental protection work in the early 1990's by developing an unique immersion and spray system to eliminate Ozone Depleting Substances (ODS) from the degreasing process for precision-machined parts. Success in ODS elimination spurred the company to institute a formal system to continually improve its environmental performance to meet the business expectations of clients. It attained ISO 14001 certification in August 1998 — the first company in the precision machining industry in Singapore to do so.

WHY GP

DEMONSTRATION

As there are many SMEs in the precision machining sector, compliance levels are generally low and the industry has many significant environmental impacts, in terms of resource use and pollution impacts. Spindex therefore aimed to minimize these impacts and also to integrate GP methodology into its existing environmental management system to demonstrate GP as a tool for continuing improvement. Subsequently it hoped to disseminate its findings to other industries and to encourage them to adopt GP methodology.



COST SAVINGS

Before embarking on GP, Spindex was already actively looking for opportunities to improve its environmental performance and had embarked on the implementation of an environmental management system. During this process, Spindex invested in an S\$ 100,000 (US\$ 57,200) waste water treatment system. The

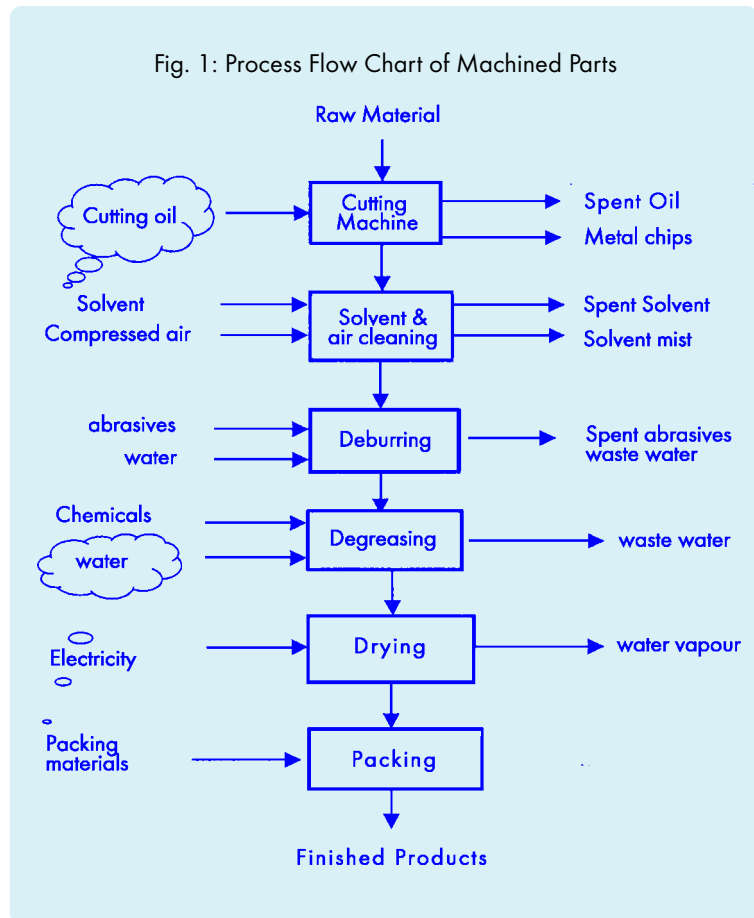


company also invested in the services of a licensed waste disposal contractor for disposal of toxic waste like spent oil etc. Given this past investment, the company decided to implement GP to harness its production improvement potential and so turn environmental initiatives into cost savings rather than expenses.

To implement GP, the company used the methodology described in the introductory chapter.

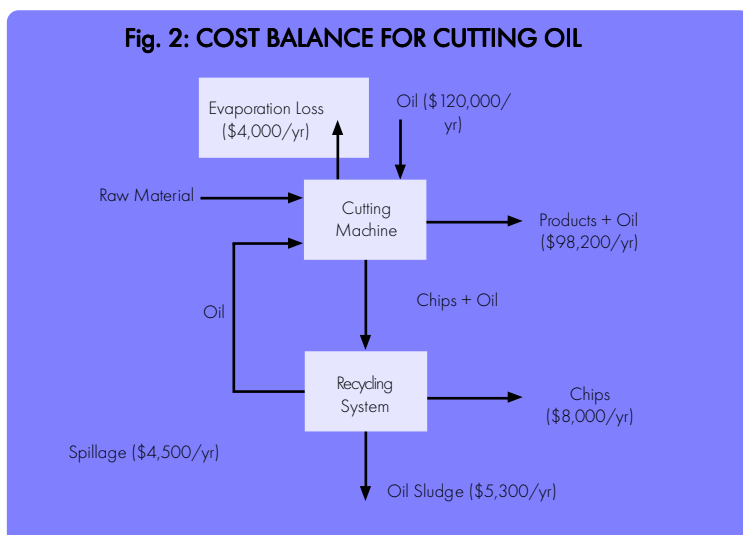
MAIN ISSUES

Spindex's manufacturing process (see Fig. 1) involves the machining of base materials such as free cutting steel and secondary finishing treatments such as grinding/deburring. Semi-finished components are degreased, dried and packed. An analysis of this process showed that, although the company had implemented a number of effective resource and waste management practices, many significant issues — both in terms of resource use and pollution generation — still persisted.



Major resource use issues included metal/alloy base material, electricity, cutting fluids, coolants, hydraulic oil, degreasing chemicals, packaging materials and water (both city water and de-ionized (DI) water). Major pollution-related issues included scrap metal, oil mist, spent oil and coolants, grinding sludge, waste water, oil spillage and volatile organic compound (VOC) emissions.

The process review showed that of these problems, cutting oil loss was key. Significant quantities of cutting oil were used in Spindex's machining operations to compensate for various losses in the system. Nearly S\$ 10,000 worth of cutting oil had to be topped into the system every month. As many oil waste minimization programs were already in place, the GP project team undertook a detailed study to determine the cause of this problem.



Using tools such as site audits, a material balance and cost balance (see Fig. 2), the GP team identified that 85% of oil loss was due to product drag-out. It was found that each year S\$ 98,200 (US\$ 56,170) worth of cutting oil was wasted. This was a surprise to Spindex's staff who, before the review, had thought that most of the loss was with metal scraps. It was found that oil was also lost through spillage, as oil sludge from the plant's oil recovery system, along with metal waste and through evaporation.

Other key environmental issues included water loss and VOC emissions. Spent city water and DI water rinses are discharged

to the waste water treatment plant. Kerosene is used to clean the metal parts in the washing area, which results in high VOC emissions.

GP SOLUTIONS & IMPLEMENTATION

Various GP options were suggested and feasibility studies were undertaken. As drag-out loss accounted for such a high percentage of oil loss, high priority was attached to oil recovery from this area. The GP team brainstormed strategies for recovering oil from short components less than 150 mm in length (eg. pin slots) and from larger components (eg. printer shafts).



For the smaller components, it was found that the main problem was inadequate draining facilities immediately after the cutting process. To rectify this, an additional oil collection tray was installed and parts were allowed to drain for at least an hour.

For larger components it was found that drainage wasn't sufficient to remove all the oil. A number of options were developed to deal with this, the most effective of which was the installation of an oil seal in the cutting machine to wipe off the drag-out oil. Tests conducted revealed that this could reduce drag-out loss by more than 40%.

Loss of oil with the sludge from the oil recovery system (which is essentially a sedimentation unit) was addressed by reducing the frequency of the sludge cleaning from once a week to once a month. Higher retention time improves oil removal from sludge due to the effect of hydrostatic pressure.

Waste water losses were addressed by recycling spent DI water (used to clean printer shafts) within the rinsing cycle. VOC emissions were reduced by fitting an end-of-pipe treatment unit comprising a demister, with an exhaust fan system for removing kerosene droplets.

GP BENEFITS

The implementation of GP solutions in the Spindex production process brought a number of significant environmental and economic benefits.

The new drag-out minimization facilities resulted in appreciable savings in the amount of cutting oil used (estimated to be over 40% for larger parts and over 10% for smaller parts). The improvements also resulted in less oil sludge generation and a reduction in the VOC problem at the kerosene wash



CUTTING FLUID CONSERVATION

The cost of the GP option to minimize oil loss from small parts was S\$ 60 (US\$ 34) for the 30 plastic trays. This generated savings of S\$ 5,460/year (US\$ 3,123). This translates into a payback period of just four days.



Modifications to the oil-recovery system management resulted in a saving of about 100 litres of oil per month. No capital investment was necessary and money was saved on manpower (S\$ 1,440/yr (US\$ 823/yr)), materials (S\$ 4,200/yr (US\$ 2,402/yr)) and waste disposal (S\$ 210/yr (US\$ 120/yr)). This gave a total saving of S\$ 5,850/yr (US\$ 3,345/yr).

WATER CONSERVATION

Water recycling measures saved about 600 litres of DI water everyday and reduced waste water generation by the same amount. This gave economic savings of about S\$ 432/year (US\$ 247/year).



VOC REDUCTION

The demister system reduced VOC concentration appreciably — from 15.73 ppm to 5.54 ppm, so improving the working environment.

OIL STAIN REDUCTION

Epoxy flooring was laid to eliminate oil stains and minimize soil contamination.

CONCLUSION

By applying GP methodology, the company has been able to identify new areas of environmental improvement, while maintaining its core focus on quality. It also helped the company to focus its attention on the most important problem areas. Before a material balance was used, the company had been focusing on recovering oil from waste chips. However the material balance clearly indicated that drag out along with products was the key problem area. This helped the company to focus its attention where it would be most effective.

GP methodology has now been integrated into Spindex's ISO 14001 Environmental Management System. The GP methodology was helpful in identifying new objectives, targets and programs for the existing EMS. GP has contributed significantly to the process of continual improvement and Spindex is now studying new aspects like energy conservation.

The various GP measures implemented have not only improved the image of the company, but also helped the company attract talented employees who were initially avoiding the precision machining industries due to its unclean working environment. This is a major intangible benefit the company derives from the improvements it has made to its environmental performance.



“We achieved tangible benefits in areas such as cutting oil recovery and water conservation.

But the main achievement of this GP demonstration project is that it has helped to change the image of Spindex. This has meant that we are now more easily able to attract young and talented people to join our industry.”

**Mr Choo Heng Thong
Managing Director
Spindex Industries Ltd**

It is hoped that this demonstration project will help disseminate evidence of the effectiveness of the GP concept and methodology to other companies in Singapore. In this way, APO and PSB aim to initiate a new era of productivity improvement and environmental protection for Singapore's industry.

Video available for this case study from:

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BANGPLEE CHROMIUM CO. LTD. (Thailand)

ABOUT THE COMPANY

Bangplee Chromium Co. Ltd. is a small scale electroplating company located in the Bangplee Industrial Estate, Samuthprakarn, Thailand. The plant employs over 20 full-time workers and handles the complete plating process from preparation to packing.

The company specializes in the plating of two major component types. These are the steel jackets of irons and the inner jackets of rice cookers. Bangplee does not prepare any reagents or chemicals itself, but buys in all necessary raw materials from outside suppliers.

WHY GP?

ENVIRONMENTAL IMPROVEMENT

The electroplating industry is a major contributor to environmental pollution. In particular, untreated waste water from electroplating factories can contain toxic metals such as copper, nickel and chromium which are hazardous to the natural environment and human health. The GP demonstration project in Bangplee aimed to show how such problems can be dealt with effectively in the context of a small/medium-sized enterprise (SME).



COST EFFECTIVENESS

As an SME, Bangplee faces the usual financial constraints of most small-scale companies. These limit the



investments it can make in environmental protection. The GP project was initiated to find solutions which combined cost-effectiveness with production improvements — showing that factory size and turnover need not stand in the way of high environmental standards.

To implement GP, the company used the methodology described in the introductory chapter.

MAIN ISSUES

As the main environmental challenge faced by the electroplating industry is waste water quality, the pre-assessment audit looked especially closely at the sections of the production process where rinse waste water is generated. The following was found:

CHEMICAL LOSS

There were substantial losses of process chemicals from both the nickel and chromium plating baths. These chemicals were being transferred to the rinsing tanks and so to the waste water stream. This was due to drag-out when work pieces were moved from tank to tank. It was also found that the solutions in these tanks were not at the optimal concentrations for efficient operation.

Bad housekeeping was resulting in poor and unhealthy work conditions and spillage losses. Such problems were compounded by insufficient training.

WASTE WATER DISCHARGE

Water use and waste water discharge were not measured or recorded. This resulted in excessive water consumption. Material usage was also poorly recorded.

Water in the plating tanks contained considerable amounts of salt and had a conductivity of about 2,000 ms/cm. This resulted in poor plating quality.

INEFFICIENCIES

The existing layout and the production sequence was found to be inefficient. There were large gaps between successive production stages, equipment layout was poor and there were a number of significant time bottlenecks.

Process parameters such as temperature and solution concentrations were not adequately controlled. Process efficiency was checked by visual observations rather than by technical monitoring. These problems resulted in excessive resource use.

The discharge area for nickel rinse and chromium rinse waste waters was not properly maintained. Collection drums were choked and overflowing.

GP SOLUTIONS/IMPLEMENTATION

To deal with waste water problems, the following changes to the nickel and chromium drag-out recovery and rinse tanks were recommended and implemented:

- The nickel drag-out tank was modified to make it more accessible and to reduce the distance work pieces had to move — so reducing drag-out losses and improving chemical recycling.



- The dipping system of the chromium drag-out and rinse tanks was improved and a spray rinsing system implemented to bring performance up to an optimum level — again reducing drag-out losses and allowing more chemicals to be recycled.

Other improvements suggested during the pre-assessment included modifications in the layout and organization of the production process and changes to some of the equipment used. The following key recommendations were among those implemented:

- The layout of the plant was improved to make the work-flow pattern more effective.
- Temperature control devices and timer clocks were installed to control immersion times. Lab facilities were set up for sample analysis.
- The configuration of the soak cleansing tanks was improved and the gas heating systems replaced by more efficient and safer electrical devices.
- The sequence of alkaline electro-clean tanks was changed to improve the surface preparation process.
- The acid dip rinse pattern was simplified and dipping time optimized.
- Drip boards were installed at all junction points between tanks to reduce spillage loss (See Fig. 1).
- A reverse osmosis filtration system was installed to produce water that was of almost de-ionized (DI) quality. This was found to be a more economical way to deal with water quality problems than the purchase of de-ionized water from an outside supplier.

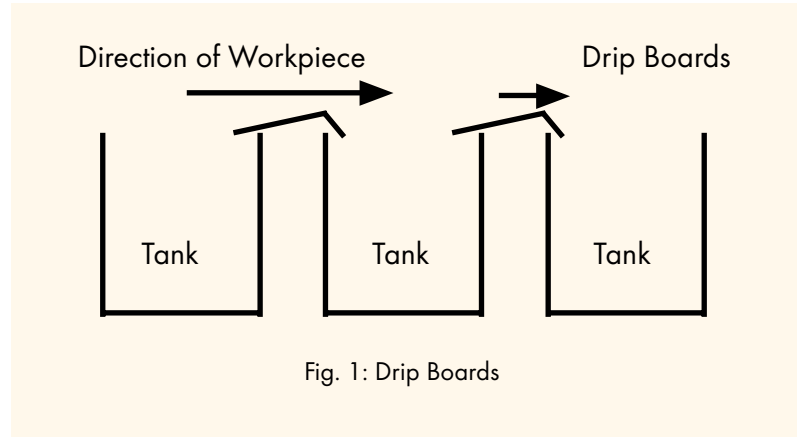


Fig. 1: Drip Boards

The need for end-of-pipe treatment for rinse water from the metal plating lines was also highlighted.

BENEFITS OF GP

MATERIAL SAVINGS

Improvements made to the nickel and chromium plating and rinse tanks increased the amount of chemicals recycled and substantially reduced the amount of chemicals used — as shown in Table 1.

	Materials Saved Kg/day	Equivalent to Kg/day	Unit Cost Baht/Kg (US\$/kg)	Total Savings Baht/day (US\$/day)
Nickel	1.64	7.85 NiSO_4 $7\text{H}_2\text{O}$	70 (1.7)	550 (13.5)
Chromium	1.46	1.40CrO_3	80 (1.9)	112 (2.7)
Total	-	-		662 (16.3)

Table 1: Chemical Savings Due to GP Implementation



PRODUCT QUALITY

Improvements made to both the nickel and chromium plating and rinse tanks drastically improved the efficiency of the equipment's operation and gave an improved surface finish to all products.

ECONOMIC SAVINGS

Total savings of 313,030 Baht (US\$ 7,738) per year were achieved. These savings were calculated in the following way:

- Savings of 32,580 Baht/year (US\$805/year) due to replacement of gas burners with electric heaters.

Expenditure on gas:	5,040 Baht/month
Expenditure on electricity:	2,325 Baht/month
Savings:	2,715 Baht/month
Capital cost of electric heaters:	10,000 Baht
Payback period:	4 months
- Savings of 81,850 Baht/year (US\$2,2023/year) due to the installation of membrane filtration system for DI water.

Capital Cost:	225,000 Baht
Annual Operating Expenditure:	38,150 Baht
Net Annual Savings:	81,850 Baht
Payback period:	2.7 years
- Savings of 198,600 Baht/year (US\$4,909/year) due to material savings.

“I personally gained benefits not only in the field of waste prevention but also in the field of new plating process technique applications.

Once they have observed GP implementation in our process, I think that both the public and plating entrepreneurs will gain more confidence that waste prevention is a viable technique.”

Mr. Prayut Chongkol
Owner
Bangplee Chromium

CONCLUSION

GP implementation in Bangplee highlighted a number of problems specific to environmental improvement in small scale factories. These included the challenge of achieving substantial waste reduction gains in a situation where there is a lack of machine and process automation. It also highlighted the particular challenge of improving disorganized and judgment-based process activity.

Through its success, however, the project showed that a systematic audit approach can be modified to suit the requirements and objectives of an SME and that this approach can bring about significant reductions in the amount of materials used in the production process and lost in the waste water stream. By showing that GP can help solve a small-scale electroplating company's key environmental challenges, the project highlighted the importance of this concept to the sector as a whole.



Video available for this case study from:

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CHIANG MAI FOOD INDUSTRY CO. LTD. (Thailand)



ABOUT THE COMPANY

Chiang Mai Food Industry Co. Ltd. is a medium scale cannery operation located in Chiang Mai, Thailand. It has about 300 employees. The company's cannery factory shares an eight hectare site with a dried fruit factory. The canning factory has a total floor area of 8,250 square meters and employs 23 permanent staff and about 300-2,000 temporary staff depending on the season. Its main products are longans, lychees, mushrooms and bamboo shoots. The factory produces between 50,000 and 100,000 cans of these products a day and sells them to both the local and international market.

WHY GP?

ENVIRONMENTAL IMPROVEMENT

Environmental issues are one of the major obstacles limiting the development of the food processing industry in Thailand. Factories in this sector generally consume a lot of water and produce large quantities of solid waste and high-strength waste water. Strict effluent regulations are now putting pressure on manufacturers to improve their environmental performance. In response, many companies have either installed expensive end-of-pipe pollution treatment technology or else they dump their wastes into the environment with inadequate treatment. Knowledge of waste reduction is limited.

Even before they implemented GP, the management of Chiang Mai Food Industry was aware of the limitations of end-of-pipe waste treatment and the burdens that this approach can place on a business. By implementing GP, the company hoped to resolve the pollution issues associated with its lychee and mushroom canning lines in a cost-effective way. As an industry leader, it also aimed to be a demonstration model for the rest of the cannery sector in the country.

To implement GP, the company used the methodology described in the introductory chapter.



MAIN ISSUES

WASTE SOURCES AND CAUSES

The review of both the lychee and mushroom processing and canning lines involved a number of different procedures. These included water and waste water monitoring using Ishikawa cause and effect analysis (see Fig. 2), a material balance analysis and eco-mapping (see Fig. 3). These investigations allowed the GP team to get a clear picture of how raw materials were used and wastes produced. It was found that the main problem in both processes was excessive waste water generation. Solid waste generation due to spoilage and process waste was also a key pollution problem.

Lychee processing was found to generate high-concentration waste water. This was due to the acid discharge from lychee soaking at the beginning of the production process and syrup spillage during canning. Washing water also added to the pollution load. Altogether about 320 m³/day of waste water was produced.

The costs of these waste water streams were calculated and it was found that: acid waste cost about 140 Baht per cubic meter (US\$ 3.5 per cubic meter); waste water from washing cost 25 Baht per cubic meter (US\$ 0.6 per cubic meter); and spillage from syrup cost 171 Baht per cubic meter (US\$ 4.2 per cubic meter).

Mushroom processing created many different waste water streams from both the mushroom washing section and from the production line. These included waste water with high BOD content and brine with a high chloride content. A lot of leakage and spillage was observed. All together between 189 and 235 m³/day of waste water was produced, costing about 10 Baht per cubic meter (US\$ 0.2 per cubic meter).

The main causes of water use and wastage were analyzed using a fish-bone diagram (See Fig. 2). Key problems were:

- Cleaning was inefficient because raw materials were too dirty, there were no spray guns or floor washing machines and workers used only open hoses.
- Acid was discharged after lychees had been soaked only one time and was not re-used.
- The perforated pipe used for lychee washing was not water-use efficient.
- The can washing machine was not being operated properly and was wasting water.
- No recycling facilities existed for cooling water.
- Workers had no awareness of waste minimization issues due to a lack of training.

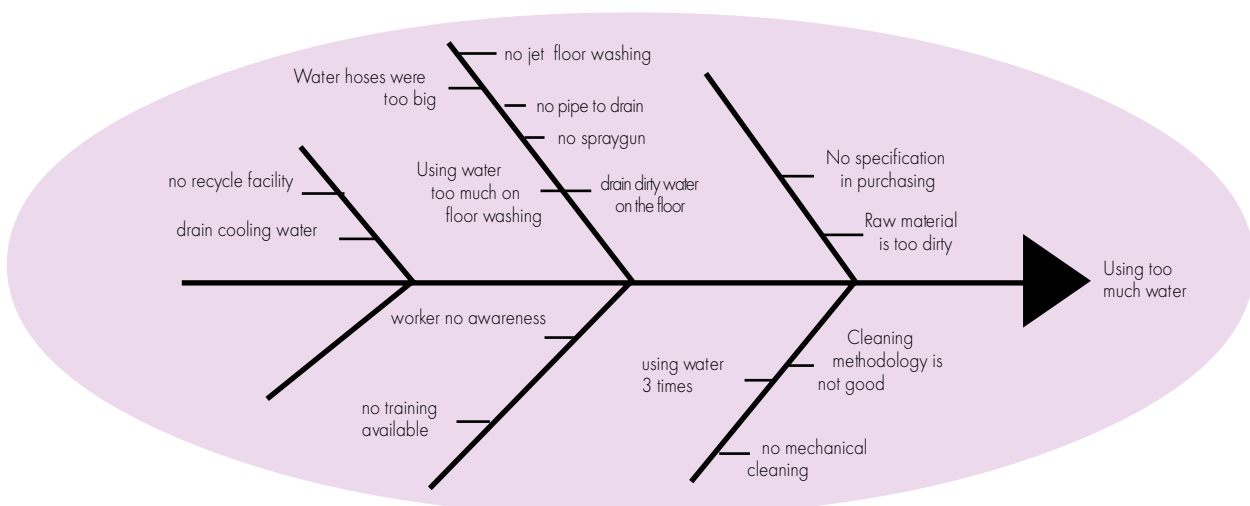
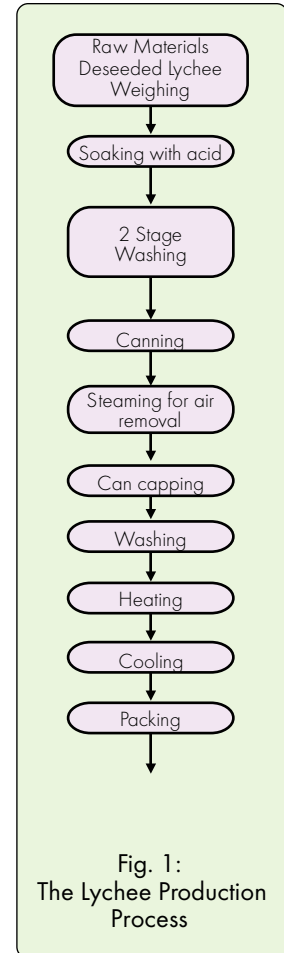


Fig.2: Ishikawa Fish-bone Diagram Showing Main Causes of Water Wastage

GP SOLUTIONS/IMPLEMENTATION

Once the main production problems had been assessed, the GP team identified and analyzed possible improvement options. For the lychee production line these involved changes in the production process and alterations to the machinery. These options were then assessed in terms of their technical and financial feasibility. A number of them, such as the implementation of vacuum capping to reduce wastewater dripping — which cost 2 million Baht (US\$ 49,440) — and the purchase of floor washing machines, were deemed to be too expensive. However the following GP options were implemented:

- The lychee soaking process was changed so that citric acid was used twice. In this way acid waste was reduced by a half, which resulted in savings of about 2,307 Baht/day (US\$ 57/day). This improvement did not carry any additional costs.
- The lychee washing process was improved by the installation of shower head sprays. This cost 5,000 Baht (US\$ 123), saved 20 m³ of water a day and saved 500 Baht/day (US\$ 12). (Payback period ten days).
- A syrup collection system was installed which reduced syrup loss by at least 70%. This led to a cost saving of 500 Baht/day (US\$ 12.3/day). The system cost 20,000 Baht (US\$ 494) which translates into a payback period of under 17 days.
- The operation of the can washing machine was improved, leakages were fixed and more efficient water hoses installed.

Ten improvements were suggested for the mushroom production line. These included specification changes and the introduction of mechanical cleaning and water recycling.

After evaluation, it was found that all options were potentially profitable with payback periods of less than 16 months. For example, simple changes such as reducing the amount of soil farmers were allowed to leave on the mushrooms they delivered would reduce water costs by between 13,950 and 52,320 Baht/day (US\$ 345 and 1,293/day).

Of the technical options, it was found that the most immediately effective measure would be to change water hoses to a smaller size and add a spray gun. This would save 15 m³/day and give cost savings of about 242 Baht/day (US\$ 6/day) (equivalent to a 12.6 day pay back period).

Unfortunately due to problems relating to raw material supply, the company was not able to implement the mushroom processing improvement options.

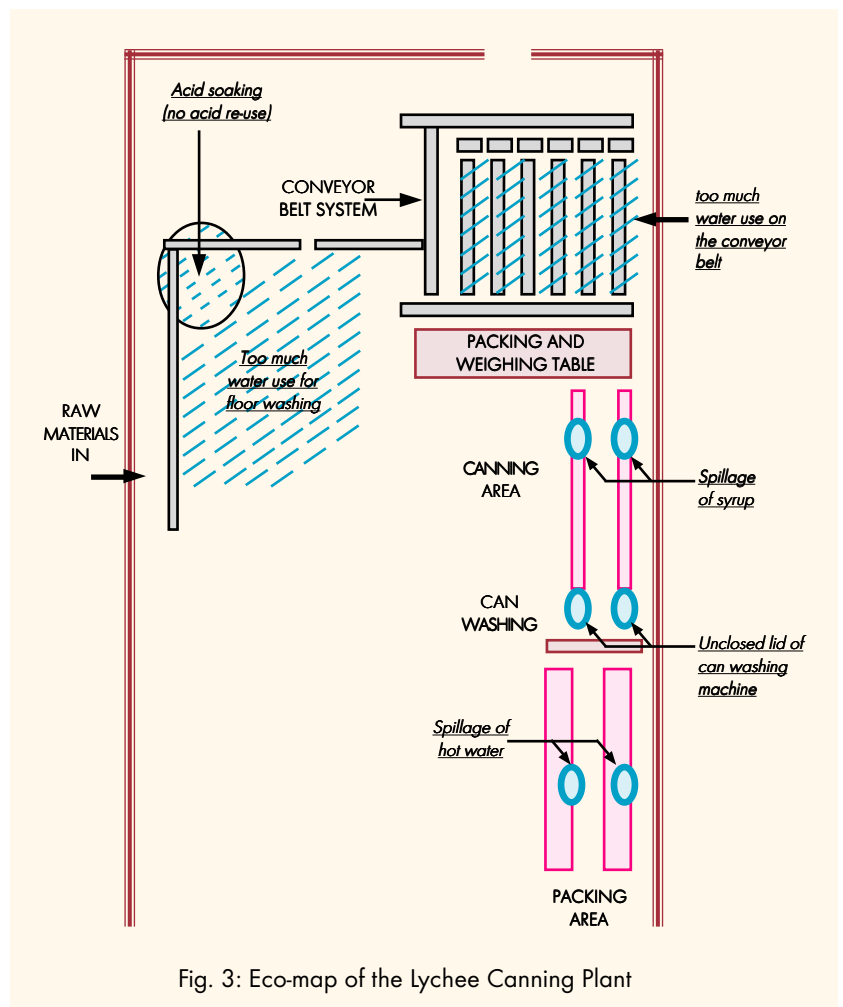


Fig. 3: Eco-map of the Lychee Canning Plant



BENEFITS OF GP

ENVIRONMENTAL IMPROVEMENTS

The implementation of GP in the lychee processing line at Chiang Mai Food Industry resulted in significant specific cost savings and reductions in the amount of waste water produced as detailed above. Overall, the total amount of waste water generated by the process was reduced by 45%. The results also showed that the factory saved up to 30% of the chemicals used in the process.

ECONOMIC SAVINGS

Based on the assumption of an average production of 25 tons/day and a production period of 90 days per season, it was calculated that the total saving from the implementation of GP options in lychee plant would be about 280,898 Baht/season (US\$ 6,943/season). With a total investment of 75,000 Baht (US\$ 1,854), this translates into a payback of much less than one season.

CONCLUSION

The GP demonstration project at Chiang Mai Food Industries shows that the same systematic analysis method can be applied to two different production processes to yield significant environmental improvements and profit gains.

The project's significance to the food processing industry in Thailand and other developing countries is potentially massive, since it shows that cost effective solutions exist to the industry's main problem, namely waste water generation. It is now expected that more factories and other industrial sectors will realize the effectiveness of GP practices as a result of Chiang Mai Food Industry's work.

“By adopting GP methodology, Chiang Mai Food Industry Co Ltd is able to save substantially by minimising citric acid and other resource usage and also on waste water treatment costs.

We expect more companies in Thailand to adopt this GP methodology and gain similar benefits.”

**Dr Suporn Koottatep
Chiang Mai University
Thailand**



Video available for this case study from:

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TANCHEM INDUSTRIES, MEERUT AND NASSER TANNERY COMPANY, VANIYAMBADI (India)

ABOUT THE COMPANIES

Tanchem Industries, Meerut is a small-scale tannery processing about 200 buff calf hides (or an equivalent quantity of cow or buffalo hides) per batch. In a year, it processes about 48 batches and employs around 30 workers in all. The unit, which is located in the northern part of India, produces nappa, oil pull nappa and other varieties of leather used by the garment and shoe manufacturing industries.

Nassau Tannery Company, Vaniyambadi is a medium-scale tannery that processes about 2500 sheep/goat skins per batch. In a year, it processes around 300 batches. The unit, which is located in the southern part of India, is 100% export-oriented and produces suedes, nappa, nubuck and other varieties of leather for garment and golf glove manufacture. It employs around 175 employees and has an annual turnover of about RS 2 billion (US\$ 45 million).

These two companies represent between them many of the main characteristics of the tannery industry in India and allow an assessment of how issues of scale affect environmental and economic performance in the sector. Moreover they allow a comparison of the different leather production processes used for hides and skins.

WHY GP?

COMPETITIVENESS

Indian tanneries are generally outdated, use obsolete technology and depend excessively on traditional skills. This means that their productivity is well below the norm for tanneries in developed economies such as Europe. However, exports from the leather sector constitute seven percent of India's export basket, making it one of the nation's top five export earners. Now, in the wake of the globalisation of the Indian economy and the liberalization of economic and trade policies, the industry is poised for further growth to achieve a greater share in the global market. Environmental excellence coupled with much-needed productivity

improvements will be vital to fully capitalize on this opportunity.

ENVIRONMENTAL IMPROVEMENT

Liquid wastes comprise the vast majority of pollution from tanneries. In general, these wastes have high biological oxygen demand (BOD), high concentrations of suspended solids, dissolved solids, oils and grease. Effluent may also contain chrome, sulfide, nitrogen and other chemicals. Improperly treated tannery waste water has severe impacts on surface water, ground water and soil quality and there have recently been mass closures of tanneries in the State of Tamil Nadu in response to this problem. GP is therefore vital to promote the establishment of environmentally friendly factories and to show that environmental protection and profitability can be harmonized particularly in SMEs.

To implement GP the companies used the methodology described in the introductory chapter.

MAIN ISSUES

The production of finished leather from raw hides and skins can be grouped under three major operations (see Fig. 1): Beam house operations; tanning operations; and, post tanning operations. All aspects of these operations were found to be potential sources of waste generation, although the beam house operations — where the raw hides are cleaned and prepared — was found to contribute over 50% of the tanneries' total pollution load.

WATER POLLUTION

As expected water pollution was found to be the main problem, with large volumes of waste with high BOD, COD, TSS and TDS produced from each unit. The impact of these pollutants was varied, and included human health problems due to waste from the spent chrome bath, soil contamination from liming waste water and ground water pollution from soaking wastewater.

Causes of this pollution included: process inefficiencies (eg. the problem of unfixed fat liquors due to the use of cold water); spillages (eg. chemicals at the neutralization stage); unoptimised and inefficient processes (eg. at the soaking and pasting stages); and, a lack of accurate measuring due to a lack of necessary machinery (eg. in the deliming, bating and degreasing stage). Poor quality control, impurities in the chemicals used, an unskilled and untrained work force and a lack of water recycling infrastructure were also highlighted.

SOLID WASTE

It was also found that a large amount of solid waste is generated from the tanneries. The major sources were unhairing, liming mud, fleshings, splitting, shavings, trimmings and buffings amongst others. However, all solid waste generated from the tannery has a market value and is sold to local vendors who come to the unit

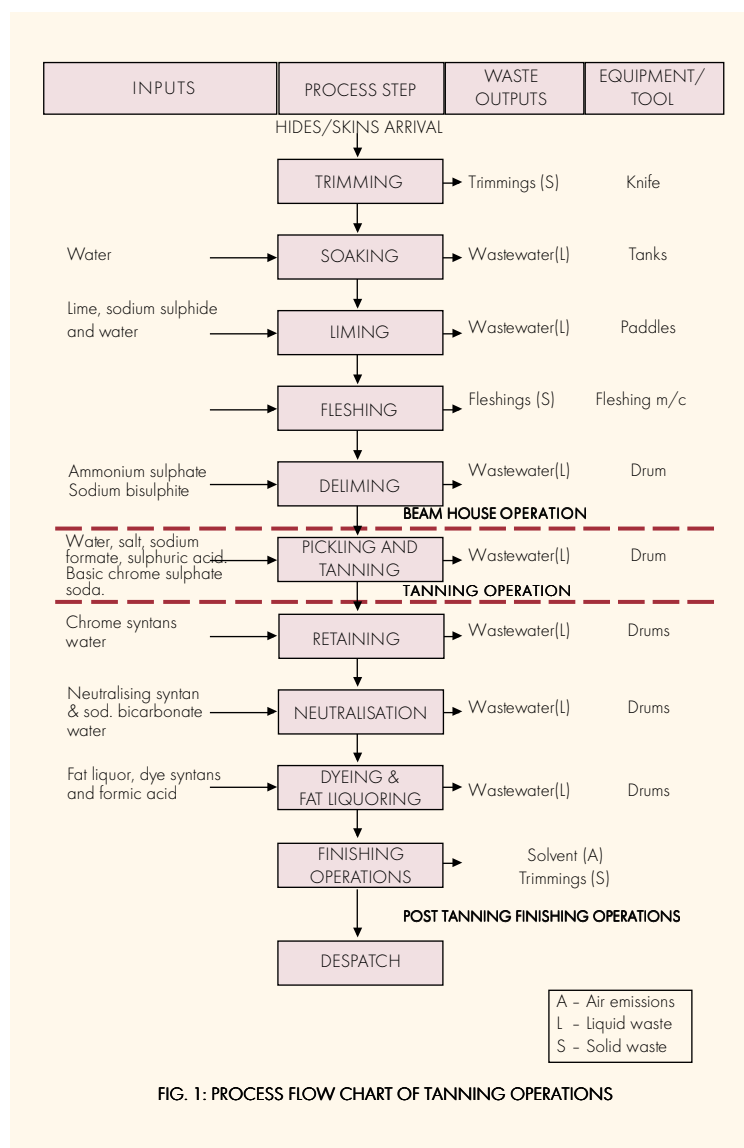


FIG. 1: PROCESS FLOW CHART OF TANNING OPERATIONS

to collect it. For example fleshings are used in the fertilizer industry, while even finished leather trims are used by cobblers for patch work.

Material balances were drawn up for both units and a cost analysis was done on the waste streams they produced. The waste stream from the BuffCalf process in Tanchem Industries was calculated to cost about Rs 2,830/batch (US\$ 63) due to chemical loss and treatment costs. For Nasser Tannery the total cost of its waste stream was Rs 8,166 per batch (US\$ 182). The company consumed about Rs 1,750,000/month (US\$ 39,000/month) of chemicals.

GP SOLUTIONS & IMPLEMENTATION

Based on a cause analysis, material and component balance, literature survey and brainstorming among team members and experts, green productivity options were developed. A total of 45 options were developed for Tanchem Industries' hide-based process and 59 for Nasser Tannery's skin-based process. These were divided into good housekeeping, process modification, material change, elimination & reduction, equipment modification, technology change and recycle, reuse and recovery.



GP options ranged from changing the felt on the roller of the sammying and setting machine (to ensure uniform pressure and a better grip on the hides) to the implementation of 'green' fleshing immediately after soaking (to reduce the use of lime and sulfide and to allow reuse of fleshings at the end of the process.) The options were assessed in terms of their implementation feasibility. Over 70% of the feasible options were implemented.

BENEFITS OF GP

Many of the implemented options were found to give substantial economic and environmental benefits.

For example, in the hide-based process, a reduction in the use of fat liquor from 18% to 8% of the weight wet blue (along with some process modifications) involved little expenditure. These changes, however, reduced organic load and brought economic benefits worth Rs 175,900 (US\$ 3,926.5). In the skin-based process recovery of chrome from the spent tanning bath and the tanning wash resulted in less chrome load to the environment, the elimination of chrome sludge from the ETP and a cost saving of Rs 727,000 (US\$ 16,235) per year. Given an initial investment of Rs 316,000 (US\$ 7,060) this translates into a payback period of less than six months.

Overall water consumption dropped by 2,000 litres per batch of 850kg buff calf hide and by 20,000 litres per batch for skins. Both the hide-based and skin-based processes' wastewater showed reductions of BOD, COD and TDS after the implementation of the GP (for details see Table 1).

	TANCHEM	NASSER
Reduction in COD Load (% Reduction)	19.1 kg/batch (10%)	157.2kg/batch (17.2%)
Reduction in BOD Load (% Reduction)	3.7 kg/batch (5.8%)	31.8 kg/batch (15.1%)
Reduction in TDS Load (% Reduction)	5kg/batch (1%)	1046.8 kg/batch (40.5%)

Table 1: Improvements in the Quality of Wastewater



One of the major achievements of implementation of GP solutions was that the marketability of products from Tanchem Industries was found to have increased by over 4.3 times. The unit's productivity also rose to about 210 batches per annum.

CONCLUSION

The GP programs at Tanchem Industries and Nasser Tanning Co. showed that the application of creative thinking can result in financial benefits for a factory while allowing it to comply with regulatory requirements. The implementation of GP at the two sites also showed that a step-by-step program could provide an effective way for both small and medium-sized enterprises to generate green productivity options.

“This project introduced a systematic approach to continuous improvement in environmental performance and productivity. Among the changes we observed was a shift in the approach and attitude of our employees — they were very much concerned about wasted resources and took all steps and measures to reduce losses.”

**Mr. A.G Naser Ahmend
Managing Director
Naser Tanning**

“The most important gain of our GP program has been that we developed confidence amongst ourselves that we could cut down our cost of production and also produce eco-friendly products without compromising on product quality.”

**Mr. Mohammed Sajid
Managing Director
Tanchem Industries**

Video available for this case study from:

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