3.7 Waste Minimization Techniques for the Pulp and Paper Industry

3.7.1 Profile of the Pulp and Paper Sector

In the Philippines, there are a total of 37 actively operating pulp and paper mills, one of which is an integrated pulp and paper mill. Of the remaining non-integrated mills, five are exclusively into pulp production while the remaining mills are into production of paper and other paper-based materials.

The industry as a whole has a total capacity of 786,600 tons per year of different grades of paper products. According to Aragon (1995), the demand for paper and paperboard is greatly influenced by economic growth, increase in school population and population growth. Reports show that the annual per capita consumption of paper in the Philippines is 13 kg as opposed to the world's consumption of 43 kg. In the country, Manila and other urbanized areas show the highest density in paper consumption.

The primary raw materials for paper making in the Philippines are recycled fibers or waste paper. This is due to the limited supply of local wood pulp and the exorbitant cost of imported wood pulp. There are even mills that use 100% wastepaper while some combine recycled fiber with imported wood pulp at a certain ratio depending on the desired quality of the end product.

Although considered as one of the key players in the economic recovery, the pulp and paper industry is also regarded as one of the major sources of environmental impacts. Their production process use significant quantities of water and discards nearly the same volume of wastewater containing various amounts of water-conveyed pollutants besides the solid and gaseous wastes generated by the process.

3.7.2 Typical Process Description – Using Virgin Pulp

In general, the three basic steps involved in paper and paperboard making are: pulp making, pulp processing and paper/paperboard production.

Pulp Making

Digesting a material, which in most cases is wood, into its fibrous constituents by means of chemical, mechanical or a combination of both operations, produces a stock pulp mixture.

Pulp Processing

When the fibers have been separated from the source material and removed of all impurities, it is bleached to improve its color and processed to a form suitable for paper making equipments.

Paper / Paperboard Production

During the paper making stage, the pulp is combined with dyes, strength building resins or texture adding filler materials, depending on the intended final product. Then the mixture is dewatered, leaving the fibrous constituents and additives on a wire or wire mesh conveyor so that the sheet is

formed in this process. A series of pressing and heat rolling bonds the fiber together and the final paper product is made.

Wastewater treatment is an obligatory step taken by pulp and paper mills prior to final disposal of the wastewater. Process wastewater is subjected to primary and secondary treatments before discharge. Some solids in the waste water are allowed to settle. These consist of lost fiber, bark and undissolved organic materials, which are removed from the waste water by means of a gravity settling ponds or primary clarifiers. The sludge generated by this operation is mechanically dewatered and thickened prior to its final disposal into a dedicated landfill or by thermal treatment.

Diluted and residual particulate organic materials are removed during secondary treatment by using some form of biological treatment. Bacteria and some common microorganisms convert the organic materials into carbon dioxide and water. Aerated lagoons, activated sludge, anaerobic systems and trickling filters are usually used in this process. Sludge is also generated.

3.7.3 Typical Process Description - Using Recycled Paper

Pulp making using recycled paper as raw material undergoes these key process operations: pulping, deinking, screening, cleaning, and washing. Paper making processes is the same as using virgin pulp.

In pulping, waste paper goes to the pulper where it is broken down into individual fibers. The deinking process separates the ink from fibers. The waste paper then goes through three types of screening namely coarse screening, pre-screening and fine screening.

In screening, the contaminants are separated primarily on the basis of size as it passes through the screen perforations or holes/slot. In cleaning, the contaminants are separated mainly based on specific gravity/density difference with respect to fiber and water. In flotation, air is used to separate ink particles from a pulp suspension through a chemical washing process. A slusher turns the old paper into pulp and detergent dissolves and removes the ink. In the thickening process, the stock suspension is converted to higher consistency and white water is recovered and reused as dilution water for the next operation. By dispersion, contaminants are reduced in size and homogenously distributed so as to render them invisible to the naked eye. In washing, excess chemicals/anionic trashes as well as dispersed contaminants are removed while recovered water is loaded in the wastewater treatment facility.

3.7.4 Waste Minimization Options

Table 7 describes some waste minimization options for the pulp and paper industry for both using virgin pulp and wastepaper.

Elemental Chlorine-Free Bleaching. The bleaching method used in the pulp and paper industry is of considerable importance when discussing waste minimization and environmental impacts. Elemental chlorine-free bleaching where chlorine dioxide instead of the elemental chlorine is used, has demonstrated to improve the overall environmental performances of the bleaching operation. This substitution consequently reduces the concentration of organic compounds and dioxins in the effluent; lowers the toxicity, adverse ecological effects, degree of persistence in the environment and potential bioaccumulation.

Table 7. Waste Minimization Opportunities for Pulp and Paper Mills

Options	Opportunities
Chlorine Free Bleaching	Explore the use of chlorine dioxide or non chlorinated chemicals such as hydrogen peroxide and ozone to improve the environmental performance of bleaching operations
Alternative Pulping Technologies	Reduce emissions of sulfur compounds
Use of Non Wood Fiber Sources	Substitute wood fiber with non wood sources to reduce environmental impact
Black Liquor Gasification	Use as an alternative to conventional kraft recovery furnaces to recover energy and chemicals in the black liquor solids during kraft pulping
Use of Whitewater in Hydropulping	Reduce water consumption and increase fiber recovery
Install Save-all equipment for whitewater processing	Separate fiber from water for reuse
Counter current washing	Reduce water, energy and wastewater
Improved sensors and process control	Improved monitoring of the performance of technologies
Cooling water / condensate reuse	Reduce water consumption and wastewater generation
Water use reduction and Closed Bleach / Effluent Systems	Aim for effluent free production process

Total Chlorine-Free Bleaching. Total Chlorine free bleaching on the other hand uses non-chlorinated chemicals such as oxygen, hydrogen peroxide and ozone (sometimes with the aid of enzymes). This process reduces if not totally eliminates the formation of chlorinated compounds in the effluent.

Alternative Pulping Technologies. These technologies reduce and eliminate the use of sulfur compound in pulping, thus, reducing the emission of sulfur compounds and nuisance odors caused by the presence of sulfur. Some of these are energy intensive as compared to traditional pulping techniques.

Use of Non-Wood Fiber Sources. Non-wood fiber sources like straw; bagasse, bamboo and kenaf may be used in place of wood fiber in papermaking. And unlike wood fiber, the manufactur-

ing processes of these fiber sources have fewer and less harmful impacts to the environment.

Black Liquor Gasification. Black liquor gasification is being researched as an alternative technology to a conventional kraft recovery furnace. Gasification is used to recover the energy and the chemicals in the black liquor solids generated during kraft pulping. Instead of direct burning of the solids, the volatile components of the black liquor are gasified. Sodium is recovered from the black liquor at the gasifier, whereas sulfur is recovered when the product gas is cleaned using a scrubber. The sodium and sulfur are then processed to regenerate the kraft pulping chemicals. The cleaned product gas stream is used to power a turbine or combined-cycle gas and steam turbine to generate heat and energy for the mill's use. Gasification systems have on average smaller capacities than traditional recovery furnaces. The use of multiple gasifiers would probably be required to match the energy and production needs for larger mills. The black liquor gasification used in conjunction with gas turbine cogeneration systems has the following advantages over traditional recovery furnaces:

- Higher overall energy efficiency
- Lower volume of gas requiring treatment
- Lower emissions (both gaseous and particulate)
- Higher inherent safety; no explosion hazard posed by molten smelt, which is present in recovery furnaces
- Higher adaptability to handling variations in liquor capacity by using multiple gasifiers or by other process modifications

Use of Whitewater in Hydropulping. Use of whitewater in the hydropulping process reduces water consumption and enables fiber recovery.

Install Save-all Equipment for Whitewater Processing. Save-all is solid-liquid separation equipment for paper machine water. It is used to separate fiber from the water for reuse. The filtrate is reused to any water-consuming process. The fiber can be returned to the process for papermaking. Save-all reduces water consumption and wastewater and sludge generation.

Counter current washing. This waste minimization option can be applied at the washing of pulp and in the bleaching stage. Counter current washing means that the filtrate used for each washing stage was washwater from the previous (less clean) stage. In the bleaching stage, counter current washing can be done by reusing the filtrates (from hypochlorite or chlorine dioxide stage) as dilution and washwater for the first bleaching stage. This technique reduces water and energy consumption and wastewater generation.

Improved Sensors and Process Control. Sensors and controls, if designed and positioned within the manufacturing process properly, can help improve the environmental and energy performance of existing and developing technologies used in the industry, while also maintaining the performance specifications of the finished product.

Cooling Water/Condensate Reuse. Reuse of cooling water and condensate has been proven effective in reducing water consumption and wastewater generation. Cooling towers can be used to lower the temperature before recycling or reuse. Water treatment chemicals may be added to prevent the growth of algae, thus prolonging the life of the cooling water or condensate.

Water Use Reduction and Closed Bleach/Effluent Systems. Water use reduction or complete elimination of aqueous discharges from the pulp and paper-manufacturing process would provide obvious cost savings and environmental benefits. These benefits, however, would need to be weighed against the costs of redesigning and operating an effluent-free production process. Costs for new equipment, redesign, retrofits, and construction would be offset to some degree by reduction or elimination of wastewater treatment and off-site disposal of other process wastes.

For more information regarding waste minimization and other waste management practices for the pulping, paper machining, and other operations in the pulp and paper processing, refer to the Development Bank of the Philippines' Sectoral Guidebook "An Evaluation Guide for Environmental projects in the Pulp and Paper Industry" and the "Pollution Management Guidebook" prepared under the USAID Industrial Environmental Management Project.

4.0 Waste Minimization Success Stories

Waste minimization programs were successfully implemented by four model companies representing the focus industry sectors: Food Processing, Foundry, Chemical Processing, and Pulp and Paper Milling. This chapter briefly describes each company's waste minimization options, experience and benefits.

4.1 Food Processing WM Case Study - The Experience of TSB Enterprises

4.1.1 Company Profile

TSB Enterprises is a family corporation that was established in 1990 by Attorney Thomas Emmanuel Romualdo to process food products for local and foreign consumers. The company is presently located in Tandang Sora, Quezon City. It occupies an area of about 4,259 square meters within a subdivision. Currently, the company employs 33 regular employees and more than 50 contractual workers (during peak season). It operates a one-shift schedule for eight hours (8) per day for 312 days per year. Its actual production capacity ranges from six (6) to seven (7) tons per day. The major products produced by the company are processed fruits, nuts, bakery products, processed eggs and sauces and gravies.

4.1.2 Process Description

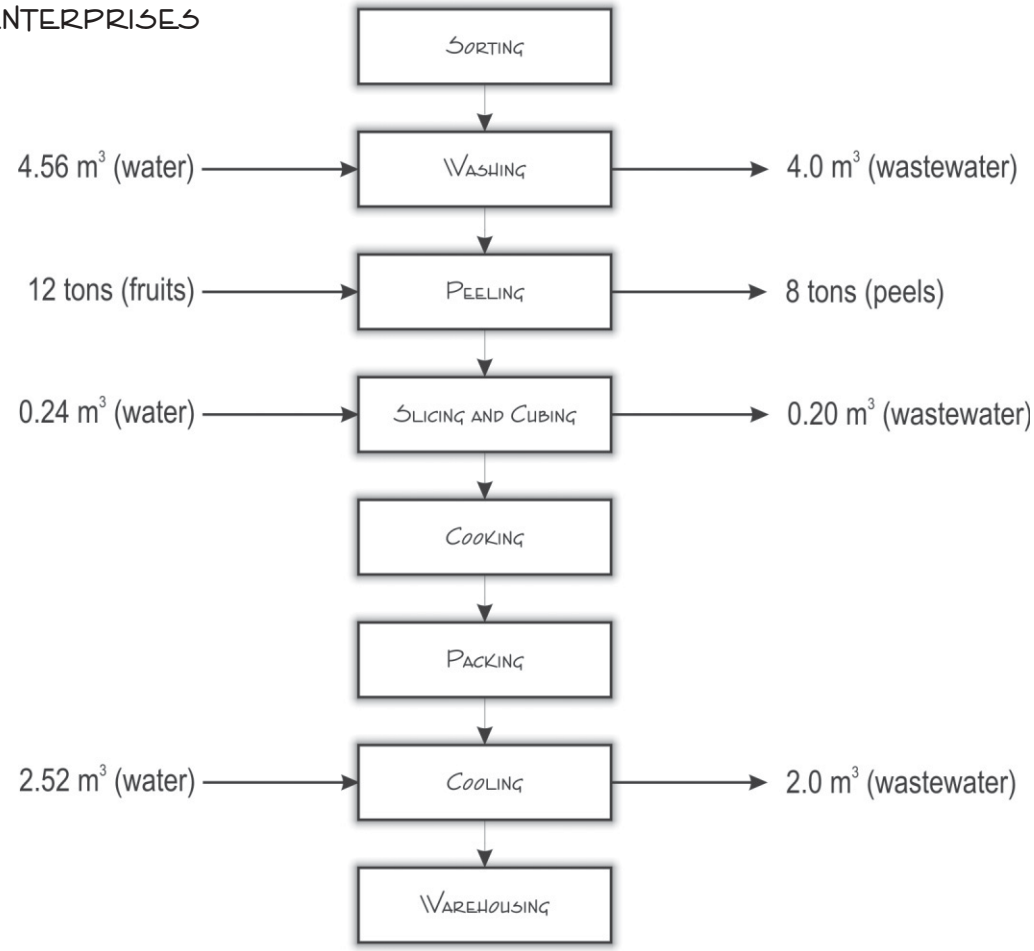
Raw materials are fruits such as jackfruits, bananas, pineapples, mangoes, etc for its raw materials. Its main operations include fruit sorting, washing, peeling, slicing/cubing, cooking and packing. After packing, TSB products are then cooled and stored in a warehouse facility.

4.1.3 Waste Stream Generated

TSB Enterprises generates solid and liquid wastes from its processes. Its daily solid wastes generated come from fruit seeds and peelings as well as jackfruit meats, which are collected monthly by a private contractor. Other solid wastes are deformed wooden and plastic crates that were used to protect fruits during transport, transfer and storage. TSB also generates rejected or destroyed plastic bags and cups as well as defective boxes and cartons, which are usually returned to the supplier.

On the other hand, TSB's liquid wastes come from various sources. Its main sources of wastewater come from product cooling as well as the washing of fruits, floors, and equipment. The company

Figure 10
Process Flow Diagram of
TSB Enterprises



averaged about 14,794 m^3 of wastewater in 2002 at an average monthly production of 1,233 m^3. Their BOD ranges from as low as 6 mg/l to 15 mg/l (pail washing tub and cooling bath, respectively) to as high as 56,220 mg/l (mango pulping). All wastewater are discharged into the open canal system of the company.

4.1.4 Implementation of WM Options

The Waste Assessment Team recommended fourteen WM options, ten of which TSB has implemented. These focused on raw material and water conservation, solid waste segregation, and improving good housekeeping practices. As a result, the volume of wastewater was reduced by 30% and its average BOD concentration was reduced by 6.8 kg per day.

Some WM Options implemented include:

- Reusing water with anti-bacteria from second rinsing of raw materials in cleaning working areas
- Using high pressure water nozzle spry in cleaning the equipment
- Maintaining cleanliness of cooling water and tub to minimize frequency of discharge by rinsing of pails before placing in cooling tub, installation of filter cloth and removal of floating material using nylon net.
- Installing a water meter for usage monitoring and control.
- Reducing the drum size in half to lessen the amount of water use
- Sanitizing tub water in cleaning the washing area.
- Sorting and segregating biodegradable, non-biodegradable and recyclable materials

Solid wastes from fruit peels is one of TSB's most significant environmental impacts. Table 8 thus highlights one waste minimization option adopted by TSB.

Table 8. Significant Waste Minimization Option Implemented by TSB

WM Option	Utilization of fruit peels as substrate for composting or green charcoal making.
WM Option Summary	TSB is generating 7-9 tons of fruit peels per week. These solid wastes are hauled and discharged into an uncontrolled dump site by a private contractor. If these wastes are converted into green charcoal and compost by MAPECON, a local pesticide company, the amount of waste disposed into the dump site will be greatly reduced and also will extend its lifespan On the other hand, expenses made on waste disposal by the company will be eliminated thereby, generating savings.
Waste Generation	7-9 tons of fruit peels/week
Generation Cost	P0.18 per kg of waste
Hauling and Disposal Cost	P1,300.00 per week
Capital Cost for Composting or Green Charcoal Making	None
Savings for Disposal:	P62,400.00 per annum
Waste Reduction	80% of the total solids generated
Impact:	Green charcoal technology utilizes all sorts of organic materials such as grasses, coffee pulp, fruit peels, leaves, etc.