CHAPTER 3.0 WASTE AUDIT

3.1 INTRODUCTION

Waste audit is required to identify types of waste, the sources and quantities, and to locate areas which have the possibility of incorporating waste minimization program. The main objectives of conducting waste audit include:

1. identifying every waste stream in specified production line, and
2. quantifying and characterizing the waste generated.

Identification and characterization of waste was conducted in the Flaking Plant (Lot 1), which is the plant where products were processed before packaging, Technical Division which includes the quality control and quality assurance department, Administration Buildings and the cafeteria.

3.2 DESCRIPTION OF WASTE AUDIT PROCEDURE

The waste audit was conducted according to the steps below:

1) Determination of audit scope,
2) Collection of background information,

3) Distinguish and characterize input materials, product and waste stream, and

4) Evaluation of data and preparation of waste audit report.

3.2.1 Determination of Audit Scope

The determination of audit scope is essential in order to carry out waste auditing in a plant. This will allow the identification of specific points and routes that require more intensive and detailed investigation.

3.2.2 Compilation of Background Information

A waste audit protocol/worksheet was prepared, according to the worksheets recommended by the USEPA Waste Audit Guidelines (1990) as shown in Appendix 1 to Appendix 3, and the waste audit worksheets were used to collect essential background information in the plant. This includes the information on input materials, manufacturing process, waste material produced and the cost of waste management.

3.2.3 Identification and Characterization of Input Materials, Products and Waste Steams

Identification and characterization of input materials, products and waste streams were carried out by:

1) Categorizing every waste stream according to production process flow diagram,
2) Compilation of data on input and production materials including those categorized as hazardous components, data on the material handling, storage, and the rate of generation of the materials, and
3) Compilation of quantitative data on the waste streams including volume and generation rate.

3.2.4. Plant Survey

This is essential to obtain a better understanding of the possible sources of waste generation. The study included the inspection of the process line from raw materials arrival and storage to the transporting of final product, monitoring operations, observation of housekeeping procedures and interviews with operators, supervisor and appropriate staffs.

Identification and quantification of the existing potential waste stream was conducted to explore possible waste minimization from the waste stream. This was based on the observation of the flow process for four weeks. Four major sites, the Flaking Plant, Technical Division, Administration Building, and the cafeteria, were selected. Weight of waste generated was taken to quantify the rate of waste generation. The results are presented in terms of waste types and waste generation rates.

3.3 WASTE AUDIT RESULTS

3.3.1 Audit Scope

Based on the need to protect corporate secrecy, waste audit only focused on the Flaking Plant (Lot 1), which is the final product manufacturing process site, office waste generated from administration operation, Technical Division which caters for quality assurance (QA) and quality control (QC) analysis and the cafeteria waste.

3.3.2 Collection of Necessary Background Information

Large quantity of background information were available, as the company normally prepares appropriate documents according to their operating procedures to meet the standard requirement of the parent company in Germany and to comply with the local government standards. However, some of the documents were not revealed due to confidentiality. The background information available is presented in Table 3.1.

Table 3.1 Available Background Information

Background Information	Availability
I. Design Information	
1. Process flow diagram	√ *
2. Material and energy balance	√*
3. Operating manuals and process description	√
4. Equipment list, specification and data sheet	√*
5. Plant layout and elevation plan	√
II. Raw Material & Production Information	
1. Material safety data sheets	√
2. Product and raw material inventory records	√ *
3. Operating procedures	√ *
III. Environmental Analysis Information	
1. Waste analysis reports	√ #
2. Waste manifest	√ #
3. Waste transport and disposal records	√
4. Environmental audit reports	√
IV. Economic Information	
1. Waste treatment and disposal cost analysis reports	√
2. Product, utility and raw material cost	√ *
3. Operating and maintenance cost.	√ *

Note: √ = Available information

* = Information available but not revealed by the facility

\# = Information available but incomplete.

3.3.3 Identification and Characterization of Input Materials, Products and Waste Stream From the Specific Sources

Flaking Plant (Lot 1)

Waste generated was closely related to the activities and type of material being used in the process. Some of the materials in the list of inputs were identified as hazardous while others were non-hazardous wastes. The hazardous materials such as calcium hydroxide and various chemical additives, which were purchased in the form of fine particles, can cause various health hazards if not handled appropriately.

The materials such as calcium hydroxide were delivered to the facility by truck or lorry, packed in paper bags of 25 kg or metal drums of the capacity of 230 kg. These materials were stored in the warehouse before utilization in the manufacturing processes in Lot 1. Forklifts were used to transfer the materials from storage to the plant for usage. The bags used for packing were disposed of as hazardous waste due the contamination of trace amount of hazardous materials, while the metal drums of the catalyst were reused to store scheduled wastes from various plants in the facility.

Inventory of input materials is always maintained by the purchasing department to ensure that only sufficient quantity is stored at anytime to avoid problems of expired raw materials. The expected shelf life of the materials ranged from one to two years.

Products

The final products of the company were either in the form of pastilles, flakes or liquid. The products range from basic materials for detergent industries to complex combination materials for pharmaceutical industries. They have different shelf-life depending on the number of carbon in the chemical chains and the additives supplemented in the final steps.

The products in the form of pastille and flakes were packed in 20 kg paper or poly-ethylene bags automatically or in 600 kg bulky bags, according to customer requirement; sewn, packed together with at least 20 bags on wooden pallet and wrapped with shrinking wrapper before being stored in metal containers for export.

Waste Stream Assessment

Various waste types were generated, ranging from empty bags of raw materials, shrinking plastic wrappers, damaged wooden pallet, damaged paper, and poly-ethylene bags, processed wastes, housekeeping waste from sweeping or vacuuming and pollution-control device waste from capture system. Figure 3.1 illustrates the processes involved and the wastes generated from each step while the waste type associated with the process is shown in Table 3.2.

Most of the waste generated was in the form of pastilles and flakes of the final products. It was generated continuously during pastillation, weighing, bagging and palletizing. Vacuum was used to collect spilled flakes meanwhile spilled pastilles were swept with

fibrous brush and brooms. Spilled products were collected and stored for reuse or remelting after QC approval. Spilled pastilles and flakes, which were highly contaminated with unwanted particles that cannot undergo reblending or remelting, were collected and stored in polyethylene bags for sale as low-grade items to various buyers.

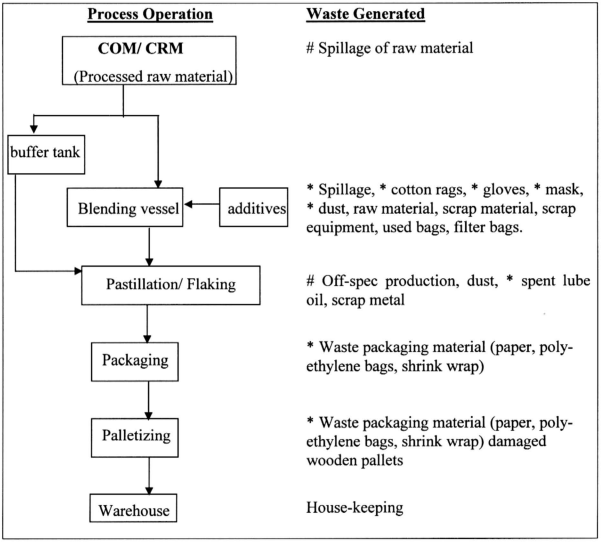


Figure 3.1: Waste Generated During The Process Operation in Flaking Plant (Lot1).

Note : * = disposed as scheduled waste,

= residue is collected to be reused.

Table 3.2: Waste Generated from Each Activity in Flaking Plant.

Activity	Waste Generated
Plant cleaning	- water, product waste #, waste packaging.
Pastillation process	- off-spec production accumulation #, dust, spent lube oil *, scrap metal (spoilt parts).
Packaging	- waste packaging material (paper, poly-ethylene bags, shrink wrap) damaged wooden pallets.
Palletizing	- dust, waste materials (shrink wrapper, label, paper), damaged wooden pallet.
Remelting/reworking off-spec product	- spillage of non-conformance product liquid*, solid waste *, paper.
Blending reaction	- dust, raw material waste #, drums #, used bags, filter bags, spillage of raw material #, scrap equipment, damaged personal protection equipment *.
Pumping	- spillage of product and raw material #, scrap equipment.
Pipelines, vessel and pastillator cleaning	- water, used bags and drums, mixed and unknown products or rejects #.
Rebagging	- packing material waste *, bags, plastic, shrink wrapper, waste from sewing material.

Note : * = disposed as scheduled waste,
= residue is collected to be reused

Excess calcium hydroxide, product residue in tank wall or excess chemical used in the manufacturing process was dissolved in steam and sent to the wastewater treatment plant (WWTP). Skimmed fats were collected from the fat traps, stored in metal drums and disposed as scheduled waste. The quantity of wastewater generated increased during cleaning and washing of the reaction tanks especially when there was a need for change in the production.

Technical Division

Waste generated in the Technical Division was closely related to the QC activities and QA activities, and the type of the material being used in the process. Some of chemicals used in the activities were hazardous while the others were non-hazardous. The hazardous materials include acids, solvents, reagents, and various chemical additives, which were purchased in the form of liquid, pastilles and fine particles, and can cause various health hazards if not handled appropriately.

The chemical supplier delivered the materials in plastic and glass bottles, or metal drums to the facility. These materials were stored in the QC store before being used in the QC and QA activities. Inventory of input materials was maintained by the purchasing personnel. A sufficient level of material was maintained to avoid problems of expired raw materials. The expected shelf life of the materials ranged from one to two years.

Waste types generated range from empty chemical reagent plastic containers, glass reagent bottles, contaminated rags, contaminated gloves, residual chemical, solvents,

acids and others. The process flow and the type of waste generated in the facility are illustrated in Figure 3.2.

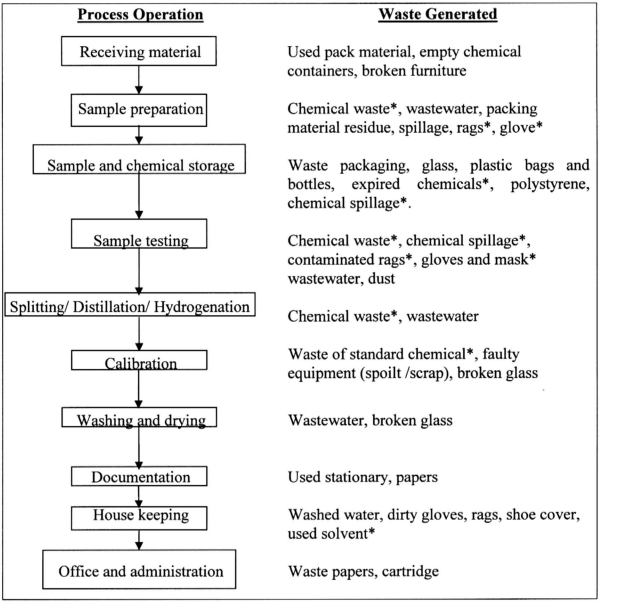


Figure 3.2: Process Flow in The Technical Department and The Waste Generated

Note : * = disposed as scheduled waste,
= residue is collected to be reuse.

Table 3.3 shows the wastes generated from the activities conducted in the Technical and QC Department.

Table 3.3: Waste Generation Associated With The Main Activities Conducted in Technical Division Department.

Activity	Waste Generated
Sample testing	Chemical waste*, wastewater, packing material residue, spillage, contaminated rags*, gloves and mask*
Calibrating equipments	Waste of standard chemical*, faulty equipment (spoilt /scrap), broken glass
Washing and drying	Wastewater, broken glass
Documents preparation	Used stationary, papers, cartridge
House keeping	Washed water, dirty gloves, rags, shoe cover, used solvent*

Note : * = disposed as scheduled waste

Most of the waste generated by the Technical Division was in the form of liquid. It was generated continuously as the QC analysis need to be carried out when samples arrive from the plants. Leftover samples were sent back to the plant for rework, reblend or remelt. Highest percentage of residue from the tests conducted was in liquid form. The residue included analyzed samples, chloroform, non-halogenated solution, halogenated solution and mixed solid waste. Sample residue was sent back to the plant or sent to WWTP. The non-halogenated solutions were stored in glass bottles and left for hours to allow phase separation to occur. The upper phase of the solution was separated and disposed together with chloroform as scheduled waste in high density, poly-ethylene (HDPE) drums while the lower phase was sent to the WWTP.

Mixed solid waste which consisted of recyclable items and contaminated wastes were segregated in their appropriate containers. Glass was kept in glass collection containers, and papers at paper collection center, to be collected by the contractors. Metal scraps were collected and sent to metal scrap buyers while textiles, including cotton rags were collected and sent to contractor to be cleaned and reused. Empty plastic containers were either cleaned and reused or sent to plastic recycling containers. The solid scheduled wastes were collected in plastic bags and stored in HDPE drums for disposal. Frequency of disposal of the chemical waste was not on a regular basis. The chemical waste, particularly scheduled waste, was disposed when it has almost filled the storage containers while the general non-scheduled waste was collected and disposed of daily.

Administration Buildings

The waste generated at the administration buildings was closely related to the activities, mainly documentation and administration works. The wastes were from the Commercial Department, Human Resource Department, Finance Department, Corporate and Administration, Information System Department, Instrument Department, Electrical Department, Shipping Department, Logistic Department and Technical Store.

Most of the wastes generated from here were non-hazardous while a very small percentage such as batteries was considered scheduled wastes, which require appropriate disposal. The materials used for activities in the administration building mainly were

papers and stationeries and these were delivered to the facility and stored in the Main Administration building before being distributed to the various departments.

Table 3.4 to Table 3.11 show details of wastes associated with the activities conducted in the departments. Figure 3.3 illustrates the waste generated from the activities at the Technical Store.

Table 3.4: Types of Waste Generated by Specific Activities in Human Resource Department and Finance Department

Activity	Waste Generated
Reports preparation	Waste paper, waste stationary
Medicine requesting	Bandage, plastic, expired medicine*, used packaging materials
Document Stamping	Waste paper, ink
Paper shredding	Waste paper
Photocopying	Waste toner, waste paper
Conduct Training	Used stationary, food containers
Washing	Wastewater, used sponge, brush, rubber glove, apron, food waste.
Cooking and food preparation	LPG leakage, food containers, cooking oil, food waste.
Pest controlling	Pesticide spillage*
Document typing	Waste cartridge
Storing	Waste paper, waste box, cabinet scrap
Cheque preparation	Waste stationary/cheques

Note: * = disposed as scheduled waste

Table 3.5: Types of Waste Generated by Specific Activities in Electrical Department

Activity	Waste Generated
Cable installation	Cable ties, cable glands, junction boxes, gloves, conduit pipes fitting, cable trays, cables, cans, boxes, drums, cotton rags, tools, safety-belts, contaminated cotton rags and gloves.
Electrical installation	Fluorescent tubes, bulbs chokes, ballast, starters, pilot bulbs, relays-start-stop button, contractor plug tops, cables lugs, cables, cable glands, electronics card, batteries, chassis, switches, empty cans, cotton rags, gloves, teflon seals, tissue paper, spillage of lubricant oils.
Electrical equipment installation	Cables, cable glands, cable lugs, contractors relay, bulbs, socket, lubricant oil spillage, cotton rags and gloves.
Testing and normal running of generator set	Damaged tools, mineral oil spillage, contaminated wastewater, contaminated cotton rags and gloves.
Servicing of generator set (by contractors)	Cotton rags, gaskets, tissue papers, tools, electronic cards, wastewater, faulty batteries, mineral oils spillage, contaminated gloves and rags.
Servicing equipment	Cables, fuses, connectors, capitators, electronic cards, bolt and nuts, screws, gaskets, fans, timers, solenoid valves, cables glands, cables ties, cables, motors, tools, bearings, cotton rags, tissue paper, drums, cans lead, contaminated water, mineral oil spillage, spoilt batteries, spent mineral oil, gloves and rags.
Servicing fire fighting equipment	Tools, bell, electronic cards, cables, used batteries (Ni-Cd).
Servicing air conditioning units	Used compressors, expansion valves, copper tube, electronic cards, blower fans, tools, used teflon seals, gasket, plastics, cans, filters, faulty fuses, chemical spillage, wastewater, gloves and rags.
Drilling	Scrap metal.

Table 3.6 Types of Waste Generated by Specific Activities in Instrument Department

Activity	Waste Generated
Equipment servicing, calibration and operation	
♦ Level-indicator	Wastewater, chemicals
♦ Conductivity	Scrap metal, tubing, fuses, cables, cans, screws, batteries *, electronic cards, electronic amplifier, body casing.
♦ Pressure	Teflon seal, plastic, glass, tissue, rubber, o-ring gasket, filters, calcium silicate *.
♦ pH analyzer	Dust, dirt
♦ On-line GC analyzer	Spillage of mineral oil *.
♦ Weighing machine	Spent mineral oil *, paper sand, contaminated rags *, gloves*, cleaning solvent*
Servicing equipment	Dust , spare part materials, waste cotton rags, cotton buds, gloves, tissues, and chemical containers.
Instrument installation	Rockwool, calcium silicate*, gaskets, pipe, welding rod, bolt & nuts, steel brackets, cables, cable lugs, copper tubing, steel tubing, tools, flexible steel hose, sponge, cable glands, plastic bottles, teflon seals, cable ties, paper, contaminated rags*, contaminated gloves*, water, dust.
Control valve calibration and servicing	Damaged tools, calibrators, plug & seat, copper tubing, metal gaskets, packing, bolt and nuts, pressure gauges, spring positioners, PVC tubing, diaphragms, wastewater, dust, dirt
Instrument trouble-shooting & loop checking	Paper, wastewater, damaged tools, calibrators, cables

(Cont'd...)

Table 3.6: Types of Waste Generated by Specific Activities in Instrument Department (Cont'd.....)

Instruments and valve operation controlling	Dust, product leakage from packing, flanges connections.
Making gasket	Dust, damaged tools, hydraulic oil spillage, cotton rags, gloves
Transporting	Dust, scrap metal, tires, tubes
Purchasing requisition	Paper and stationary
Receiving equipment	Waste woods, boxes, pallets paper, polyfoam, plastic, damaged tools
Measuring instruments using radioactive sources	Leakage of radioactive source

Note: * = disposed as scheduled waste

Table 3.7: Types of Waste Generated by Specific Activities in Shipping Department

Activity	**Waste Generated**
Requesting for transportation	Waste paper and cartridge
Isotank cleaning	Solid waste, wastewater
Handling & Storage in the Port Awaiting	Leakage, spillage
Transporting	Leakage, spillage
Clearing and delivery to customer premises	Leakage, spillage
Documentation/ coordination	Paper waste

Table 3.8: Types of Waste Generated by Specific Activities in Logistics Department

Activity/ Unit	Waste Generated
Loading of finished product	Water (flushing), spillage during loading, dirty rags, damaged plastic security seal, used personal protective equipment.
Unloading of finished product	Water (flushing), dirty gloves and rags, spillage during unloading, damaged plastic security seal, used personal protective equipment.
Drumming of finished product	Water (flushing), dirty gloves and rags, spillage during unloading, damaged drum, tap seals, wooden pallets, empty marking and solvent containers, spent filter bags, cartridges, used personal protective equipment
Line flushing and cleaning	Wastewater, dirty rags and gloves
Third party cleaning of tanker (isotank secondary cleaning)	Wastewater, dirty rags and gloves
Housekeeping	Wastewater and soap water, rubbish
Product house cleaning	Water (hose cleaning) dirty rags and gloves
Decanting of finished products in drums	Empty used drums, damaged drums and tap seals, water and soap, dirty rags, wooden pallet, 2nd hand carton, spillage during decanting.
Stuffing of containers	Damaged packaging material, damaged drums and bags, spillage during stuffing.
Prime mover & forklift servicing (3rd party)	Spent lubrication, hydraulic fluids, faulty spare parts and accessories

(Cont'd...)

Table 3.8 Types of Waste Generated by Specific Activities in Logistics Department

(Cont'd...)

Activity / Unit	Waste Generated
Label producing	Spent label, spent stencil, empty ink containers.
Cargo Readiness (bags & drums)	Water (cleaning), empty ink containers, damaged packaging material and wooden pallets.
Inspection of empty drums	Faulty empty drum, tap seal caps, damaged wooden pallets, spent vacuum cleaner filter, dust from vacuum cleaner.
Handling and storing of packed finished products	Damaged packing material and wooden pallets, damaged drums and bag, spillage during stuffing.
Operating forklift	Waste for radiator and battery, spent lubrication and hydraulic fluids, spillage.
Filter system cleaning and replacing filter	Wastewater, spent filter bags and cartridges, dirty gloves and rags.
Weighbridge unit	Paper, spent computer and typewrite printer ribbons, waste stationary, security seals.
Documentation of reports and procedures	Waste paper, spent computer ribbons and empty photocopy toner cartridge.
Documentation/ coordination	Paper waste.

Table 3.9: Types of Waste Generated by Specific Activities in Information System Department

Activity	Waste Generated
Buying and installing personal computer (PC)	PC, notebook, printer cable, screen filter, mouse cable, modem server.
Storage of files	Disk/Tape/Compact Disk, Scrap metal.
Documentation	Printer scrap, spare parts, waste manual book, waste cartridge, paper.
Server (Computers)	Dust collector bag waste.

Table 3.10: Types of Waste Generated by Specific Activities in Corporate Affairs and Administration Department

Activity	Waste Generated
Receiving and issuing stationary	Packaging materials, used stationary
Housekeeping	Solid waste, cleaning tools, wastewater
Landscaping	Chemical spillage, used tools.
Pest controls	Pesticide leakage, spillage, used containers.
Telecommunication tools servicing	Used cables, waste paper, Ni-Cd batteries*.
Dispatching	Boxes, styrofoam, packing material
Shredding	Waste paper
Storing	Waste paper, broken cabinets
Photocopying	Toner spillage, used containers, used paper.

Table 3.11: Types of Waste Generated by Specific Activities in Commercial Department

Activity	Waste Generated
Preparing purchase order	Waste paper, waste stationary.
Purchasing chemicals	Waste paper.
Preparing reports	Waste paper, waste stationary.
Storing	Used paper, used files, stationary, used cabinets.
Transporting	Leakage, spillage of products.
Chemical sampling	Spillage of chemicals, waste paper.

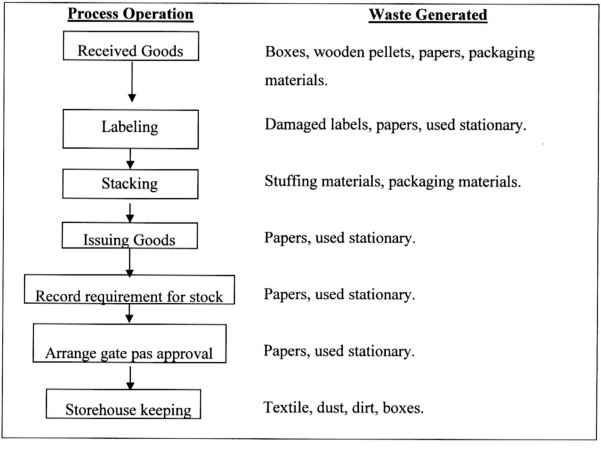


Figure 3.3: Processes in The Technical Store and The Type of Waste Generated from Each Activity

The wastes generated in the administration building were in dry form and were segregated accordingly to the type of waste before being collected by the contractors. The wastes were generated daily during office hours from 8.30 a.m. to 5.30 p.m., Monday to Friday except the weight bridge office under the Logistics Department, which operates 24 hours daily. The wastes were collected from their segregation containers and kept in black plastics bags. A licensed contractor for recycling and disposing purposes collects the segregated wastes. The company has an agreement with the contractor that there is no cost involved between both parties concerning waste disposal since the company has willingly accepted the contractor's services, while the contractor sells the recyclables to recover his costs.

Cafeteria

Waste from the cafeteria was generally mixed waste with high percentage of organic component. All of the waste was non-hazardous waste that the waste was disposed in landfill.

The goods were delivered daily to the cafeteria by the suppliers, in plastic bags, paper wraps, plastic bottles and glass bottles. These goods were stored in the kitchen before being processed in food preparation. The purchasing of fresh goods was carried in small quantity to avoid problems of spoilage of goods particularly fresh and unprocessed goods.

The food served in the cafeteria is prepared daily at the cafeteria kitchen. The food was prepared twice daily for the morning shift and the afternoon shift ranging from light-meals to heavy-meals. Food was served to customers in plastic plates, bowl and others.

The main waste type generated was organic waste from food preparation and from leftover food. Others included plastic bags, paper wraps, plastic and glass bottles and others. Figure 3.4 illustrates the waste generated from the activities conducted in the cafeteria while waste types associated with the process is shown in Table 3.12.

Table 3.12: Types of Waste Generated from The Activities in The Cafeteria.

Activity	Waste Generated
Kitchen cleaning	Plastics, papers, food residues.
Delivery of raw goods from supplier	Plastic bags, papers
Checking, unpacking and storing purchased goods	Spoilt goods, expired food, paper, plastic, glass, metal, organic materials
Cleaning, preparing and cooking of food	Organic materials from food preparation, water, glass, metal, plastic, paper.
Serving food	Organic waste, leftover, plastic cover, plastic bags.
Cleaning dishes, kitchen utensils and cooking tools	Organic waste, leftover, plastic straw.
Housekeeping	Dirty cotton rags, mops, spilled food waste

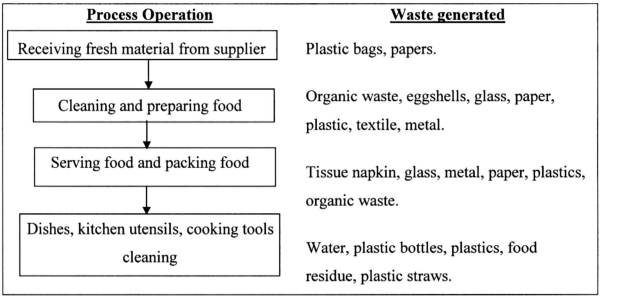
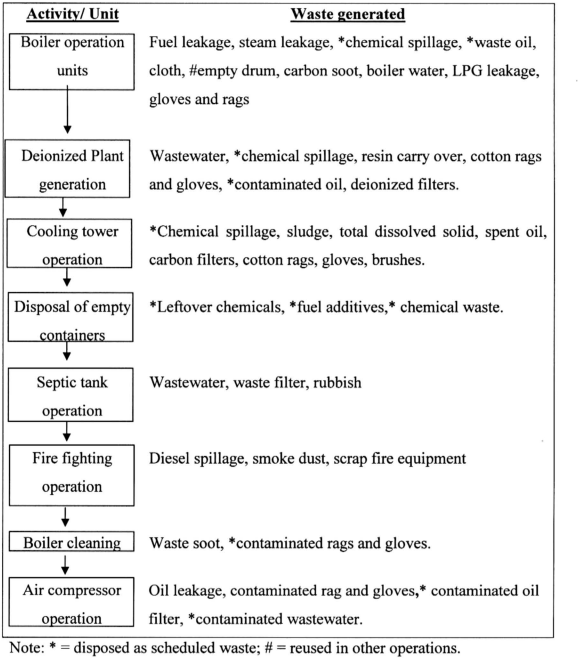


Figure 3.4: Process Flow of Activities Conducted in The Cafeteria and The Waste Generated.

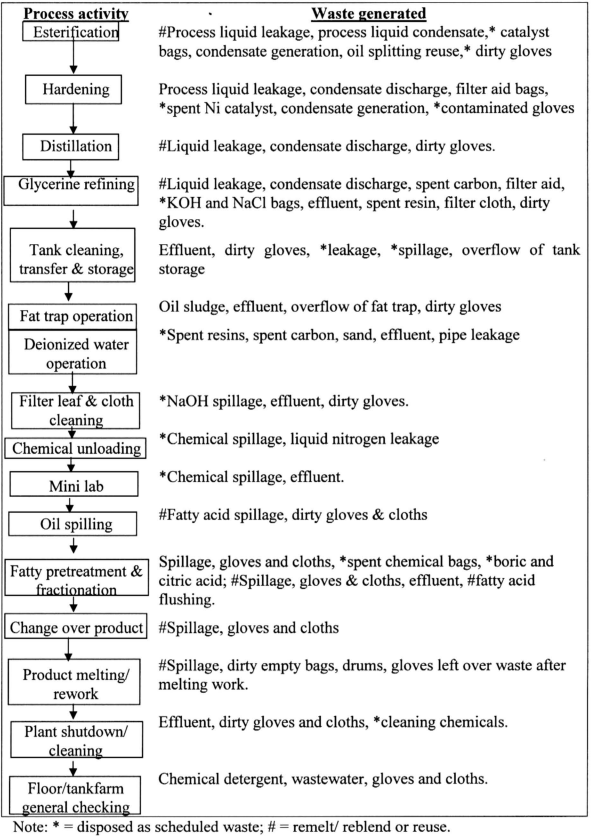
The wastes generated were either solid waste or semi-liquid waste. Wastewater from washing activities was discharged into the monsoon drain. The solid waste and semi-liquid waste were generated continuously during the hours of the cafeteria operations. The cafeteria operates from 6.00 a.m. to 12 a.m. everyday. The waste was segregated at the source, collected in plastic garbage bags twice in a day and sent to the waste bin to be collected by the appointed contractor. A special container was provided for the customers to dispose leftover food. Aluminum drinking cans were collected to be recycled by the custodian separately.

Wastes generated at other sites, which included Utility unit, Flaking Plant, CRM plant and the wastewater treatment plant are shown in Figures 3.5, 3.6, 3.7, and Table 3.13, and 3.14, accordingly.



Note: * = disposed as scheduled waste; # = reused in other operations.

Figure 3.5: Waste Generated During The Process Operation in The Utility Unit.



Note: * = disposed as scheduled waste; # = remelt/ reblend or reuse.

Figure 3.6: Waste Generated During The Process Operations in The Flaking Plant.

Table 3.13: Types of Waste Generated by The CRM Plant.

Activity	Waste Generated
Transesterification and washing	- Chemical spillage, pump seal leak, glove and rags.
Methanol removal of glycerine, ester, fatty alcohol	- Wastewater, pump leakage, raw material spillage, glove, rags and mop.
Methanol removal unit	- Chemical spillage, raw material spillage, leakage of pump seal and flanges, gloves, cotton, rags, wastewater.
Ester separation process-washing	- Wastewater, contaminated gloves, mop and rags, spillage of Cu-Zn, Cu-Zn dust, contaminated Cu-Zn drums, spent Cu-Zn.

Activity	Waste Generated
Pretreatment (Physical & Chemical)	Chemical spillage, raw effluent overflow, pretreatment sludge, lube oil spillage, used gloves and cotton rags, plastic bag, overflow sludge, used mask, empty chemical containers.
Biological treatment	*Chemical spillage, biosludge, lube oil leakage, plastic bags, used gloves and cotton rags, treated effluent.
Sludge dewatering	Dewatered sludge, lube oil leakage, wastewater, plastic bags, dirty gloves and rags, *chemical spillage.
Storage of chemical (handling)	Plastic bags, *chemical spillage
Documentation	Paper

Note: * = disposed as scheduled waste.

Figure 3.7: Types of Waste Generated by Each Process Operation in The Wastewater Treatment Plant

Table 3.14: Waste Generated During The Process Operation in The CRM

(Transesterification)

Activity/ Unit	Waste generated
Transesterification & plant washing	*Chemical spillage, leakage of pump seal, glove and rags
Methanol removal of glycerine, ester, fatty alcohol (FAL)	Pump leakage, *chemical spillage, gloves, cotton rags and mop.
Methanol removal unit	Wastewater, pump leakage, raw material spillage, gloves, mops and rags.
Ester separation process-washing#	Water
Process operation & plant washing	*Chemical spillage, raw material spillage, leakage of pump seal and flange, glove, cotton rags, wastewater, *contaminated gloves, mop and rags
Addition of catalyst (Cu-Zn)	*Spillage of Cu-Zn, *Cu-Zn dust, *contaminated gloves, cotton rags and mop, #contaminated Cu-Zn drum, *spent Cu-Zn.
Lube-oil change	Spent oil leakage, contaminated gloves and rags.
Fractionation of FAL & FAL washing#	Pump leakage, *contaminated gloves and rags, * chemical spillage
Methanol purification	Spillage of raw material, water, *contaminated gloves and cotton rags
Glycerol upgrading unit & glycerol washing#	*Chemical and raw material spillage, *contaminated gloves, rags and mop, water.
Glycerol residue drumming	Leaking of drum, drum overfill, *glycerol residue generation.
Process monitoring & sample testing	Computer scrap, wasted samples, *chemical spillage, gloves, rags, paper, water.
Storing, transfering & plant washing	*Chemical spillage, spent oil leakage, *contaminated gloves, cotton rags and mop, waste oil, wastewater, raw material spillage, used plastic bags.

Note: * = disposed as scheduled waste; # = reused for other operations.
washing# = the process of purification or upgrading of products.

3.3.4 Quantification of waste generated at the selected sites

The wastes generated at the facility were quantified to observe the generation rate of each selected sites, which included the Flaking Plant (Lot 1), the offices, Technical Department, and cafeteria. The average weight of waste generated monthly is shown in Table 3.15.

Table 3.15: Weight of Waste for Disposal Generated Monthly by The Selected Locations.

	Source Location			
Material type	⊗Flaking Plant	Technical Division	Cafeteria	Offices
Corrugated cardboard	6.0 kg	12.86 kg	-	-
Beverage cans	-	-	9 units	-
Ordinary paper	*250 kg	*67.48 kg	*9 kg	*633.5 kg
Paper bags	150 units	-	-	-
Boxes	-	2 units #	6 units	29 units
Garbage	15 kg	46.97 kg	214. 5 kg	28.4 kg
Scheduled waste	35 tonnes	83.7 kg	-	-
Batteries	-	4 units	-	20 units
Textile	*700 kg	*2.6 kg	0.1 kg	9.614 kg
Metal drums	172 units #	1 unit #	-	-
Steel items	-	-	*135 kg	*15.4 kg
Plastic items	0.8 kg	1.3 kg #	87 kg	51.2 kg
Poly-ethylene bags	16 units	4 units	-	8 units
Wood (including pallet)	300 units (pallet)	-	-	133 kg
Reaction tank filter bags	10 units	-	-	-
Stationary (pens, etc)	2 units	3 units	-	22 units
Empty cartridges	-	1 unit	-	9 units
Carbon/ stencil ribbons	-	-	-	5.7 kg
Glass items	-	*32.5 kg	*5.1 kg	*5.5 kg
Organic waste	-	-	312.6 kg	28 kg

Note: ⊗ - plant that processed the raw products from other plants into final products required by customers, (Lot 1).
* - items that will be recycled outside the facility
\# - items that will be reused within the facility

The summary of the wastes generated by each plants and units of the facility is shown in Table 3.16

Table 3.16: Summary of The Wastes Generated by The Various Site in The Plant.

Waste Generated	Main Area of Waste Generation	Method of Temporary Storage
Scheduled Waste		
*Glycerol residue	CRM	In appropriate drums
*Spent copper –zinc catalyst	CRM	In appropriate drums
*Spent nickel-catalyst	COM	In appropriate drums
*Spent lubricant oil/thermal oil	Maintenance	In appropriate drums
#Laboratory waste	Laboratory	In appropriate drums
*Spent glove, cotton rag, cloth contaminated with spent oil, spent catalyst, or glycerol residue	Maintenance/ Utilities/ Laboratory/ Plant	In appropriate containers at work stations
Non- Scheduled Waste		
*Spent activated carbon	COM	In appropriate containers
*Spent ion-exchange resins	COM/ Boilers	In appropriate drums
*Sludge cake	WWTP	In appropriate containers
#Scrap metal (iron, steel, tin-can)	Maintenance	Scrap-yard
#Wood (broken furniture, pallets)	Warehouse/ Logistic	Wood-yard
#Plastics (PVC, PP, PE)	Warehouse/ Office/ Plant	In appropriate containers
#Papers	Office	In appropriate containers
#Glass	Laboratory/ Maintenance	In appropriate containers
#Miscellaneous	All	In appropriate containers

Note : * - Process Wastes, # - Non-process waste.

Basically, the cost of disposing bulk of the waste generated by the company was very minimal due to the arrangement between the company and the waste disposal contractor. However, the disposal cost of wastewater sludge to landfill, and glycerol residue to Kualiti Alam were high as much as RM 150/tonne and RM 793.24/tonne, respectively.