ASIAN INSTITUTE OF TECHNOLOGY

SCHOOL OF ENVIRONMENT, RESOURCES AND DEVELOPMENT

ENVIRONMENTAL ENGINEERING AND MANAGEMENT PROGRAM

Term Paper II

Shampoo Production

Course: ED 78.20 Industrial Waste Abatement and Management

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1 Introduction

1.1 Background

The word "cosmetics" comes from the Greek word kosmetikos meaning "skilled in adornment/decoration". The way people wear makeup and the reasons why they wear it have changed dramatically over time and through different cultures. It is believed that cosmetics have been used as early as Egypt circa 4000 BC to fulfill beautifying needs. According to some sources numerous forms of cosmetics were extracted from the fertile land of the Nile River. The shepherds and hunters of the Mesolithic Period would often smear their bodies with locally made cosmetic products.

1.2 Cosmetic Market in Thailand

The cosmetics industry is one of the fastest growing sectors in Thailand. The year 1997 saw the fastest growth period in the cosmetic industry, with a growth rate of 20 percent. Although the economic crisis has had a negative impact on consumption levels, results during 1999-2000 show that the cosmetics industry's growth rate was at 15 percent.

Thailand's exports of cosmetic products increased by 72 percent in 2003 compared to a year before. The cosmetics market was expected to grow at an average of 18 percent in 2004, due mainly to Thailand's positive economic situation and expected positive GDP growth.

In 2005 cosmetics and toiletries in Thailand continued to record strong growth increasing by 7% of the previous year. The main factor behind growth of the market was increasing retail prices caused by an increase in energy prices and a change in consumer behavior in favor of expensive products. The most dynamic performances in 2005 were seen in skin care, fragrances and men's grooming products. On the other hand, growth in areas such as bath and shower products, hair care and oral hygiene was significantly lower as these products had already achieved widespread penetration.

Imported cosmetic products accounted for approximately 24 percent of the total market. Major countries of origin included Belgium, France, Germany, Japan, the United Kingdom, Italy, China and the United States.

As of 2003, there were 800 manufacturers of cosmetic products listed with the Industrial Works Department of the Thai Ministry of Industry. Approximately 70 percent of them are clustered in the Bangkok metropolitan area. Thailand is a major producer and exporter of shampoo products, which accounted for 40 percent of the total export value of cosmetic products in 2003.

1.3 Types of Cosmetics

Today the cosmetic products range from simple skin creams, soaps and shampoos to special lotions, base creams, moisturizers, nourishers, cleansers, protectors, rejuvenators and conditioners for body, face, hands, eyes, lips, mouth, hair, nails and so on.

1.3.1 Shampoo

Shampoo is a common hair care product used for the removal of oils, dirt, skin particles, environmental pollutants and other contaminant particles that gradually build up in hair (without stripping out).Shampoo, when lathered with water, is a surfactant (surface active

agents, i.e., wetting agent). Shampooing is frequently followed by conditioners which increase the ease of combing and styling.

1.3.2 The Worldwide Market Potential of Shampoo

The latent demand (or potential industry earnings) for hair care shampoo was estimated to be $7.4 billion in 2005. The distribution of the world potential industry earnings, however, is not evenly distributed across regions. 2005 data shows that Asia is the largest market with $2.4 billion or 33 percent, followed by Europe & the Middle East with $2.2 billion or 29 percent, and then North America & the Caribbean with$1.9 billion or 25 percent of the world market.

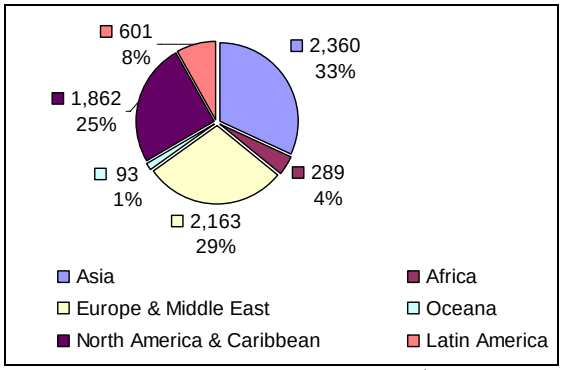


Figure 1: Worldwide market potential (US $ mln: 2005)

It shows the top 3 regions cover come 87 percent of the global latent demand for hair care shampoo

Table 1: Worldwide Market Potential for Hair Care Shampoo (US $ mln): 2005

Region	Latent Demand US $ mln	% of Globe
Asia	2,360	33
Europe & the Middle East	2,163	29
North America & the Caribbean	1,862	25
Latin America	601	08
Africa	289	04
Oceana	93	01
Total	**7,368**	**100.0**

Source: Philip M. Parker, INSEAD, 2005
www.icongrouponline.com

World Market Trend (2000-2010)

The world market for hair care shampoo had steadily declined from the period between 2002 and 2004 as these products had already achieved widespread penetration. However, it showed positive growth after 2005. The main factor behind growth of the market was increasing retail prices caused by an increase in energy prices and a change in consumer behavior in favor of expensive products. Increase in demand by growing population, widespread commercial advertisement of the hair care products, change in life style due to improved quality of life in major regions like China and India, etc were some other reasons for its continued growth.

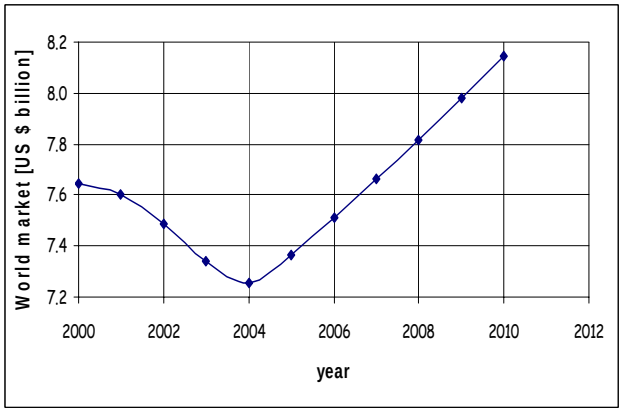


Figure 2: World market trend

1.3.3 Asia Market

In case of Asia, three most populated countries China, India and Japan have a bigger share of the product. 2005 data shows that China is the largest market with $796.18 million or almost 34 percent, followed by Japan with $539.3 million or 22.85 percent, and then India with $385.47 million or 16.33 percent of the Asian market. It shows that the top 3 regions cover 73 percent of the Asian potential demand for hair care shampoo. The other top three nations with one digit percentage share of Asian market of the product include South Korea, Indonesia and Thailand with approximately six percent, five percent and three percent respectively ***(Detail data in Appendix A)***. It has also been observed that the market of hair care shampoo shows a similar fashion as that of world market with a slight decline till 2004 from 2000 and then increase steadily after that.

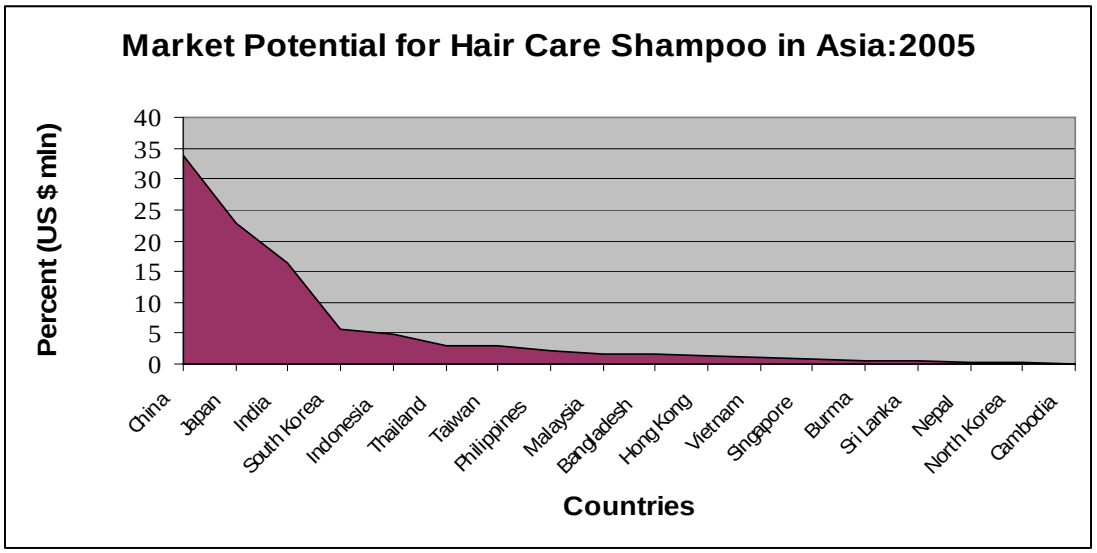


Figure 3: Comparison of shampoo market in Asia

1.3.4 Thailand

Thailand is also a major player of hair care shampoo market contributing around one percent of the total global market share. Asia contributes about 33 percent of total world shampoo market where Thailand contributes three percent of the market share. The shampoo market is almost steady for the last few years in Thailand. It has been predicted that the market would continue to grow in the similar fashion for next five years, i.e. till 2010. Bangkok city, world rank 14 in hair care market, alone contributes about 94 percent of the Thai shampoo market share whereas the city contributes 2.83 percent in the Asia region and 0.91 percent of the world market share (*Appendix B).*

2 Shampoo production process

2.1 Raw materials

Hair shampoos are highly formulated products based on a limited range of cosmetically acceptable surface active agents, plus conditioning agents, pearling agents, antimicrobials agents, colours and fragrance. Shampoo ingredients must be biodegradable as other body care products to minimize health effects. Each ingredient has specific functions and roles in shampoos. Following points given below are some of

the main components of shampoos along with their characteristics. However, the description of shampoo ingredients is given in details in *Appendix C*.

- Surfactants, including five categories (primary anionic - basic, secondary anionic - mild, amphoteric, cationic and nonionic), serve as foamers and detergents which are easy to soluble in water.

- Thickeners and foam stabilizers remain viscous to avoid precipitation and stability against hydrolysis at higher temperature or extreme pH. They can be polymers, natural gums or cellulose derivatives.

- Conditioning agents make hair easy to comb after drying. Since conditioners are effective than shampoo, very low concentrations (0.5% by weight) are sufficient. Conditioners are normally fatty components such as fatty alcohol, monoglyceride, vegetable oils, lanolin, herbal extracts and silicon.

Shampoos can be made in various physical forms such as liquids, creams, paste, aerosol and dry. Liquid shampoos are common, either clear or opaque (pearlised), containing 20–40% solids, adjusted to approximately pH 5.5 and viscosities in the ratio of 500–1500 centipoise.

Composition of shampoos can be modified for special application. Medicated shampoos generally use similar ingredients and added specific medicant. For instance, dandruff shampoos contain fungicides such as zinc pyrithione and selenium sulfide which reduce loose dander by killing Malassezia furfur. Shampoos for infants are formulated with particular emphasis on minimal eye irritancy and skin mildness. A limited range of proprietary ingredients are used to meet these needs. Totally different from hair care products for human, shampoo for animals may contain insecticides or other medications for treatment of skin conditions or parasite infestations such as fleas or mange.

2.2 Processing

Shampoos are manufactured by simple blending in a stirred vessel. Sometimes a moderate amount of heat is used to reduce the viscosity and so facilitate ease of mixing therefore vessels are equipped with low pressure steam heating coils. Vessels are typically constructed from stainless steel, although glass-lined vessels are still used in some processes.

Ingredients are weighed or metered incrementally into the mixing vessel, with thorough mixing between each addition. Dispersed and emulsified mixes are achieved by means of the central rapid speed movement. Some pearlising agents are waxy solids at ambient temperature and require melting in a drum oven or similar before use.

Demineralized water is most commonly used in order to minimize contamination of the product. In cosmetic industry, reverse osmosis membranes play a role in production of demineralized water. These membranes act as a molecular filter to remove 95 to 99% of dissolved salts and inorganic molecules, as well as organic molecules with a molecular weight greater than 100. The reverse osmosis membrane also removes more than 98% of residual biological and colloidal matter from the feed water.

No further processing is required after blending, and the product may be packed off directly from the mixing vessel by filling system which composes of auto-bottle settling machine, bottle-washing machine, filling machine, lid-revolving, label-attaching and aluminum foil clapper.

In some segments of the industry, one manufacturer may produce a shampoo base which is sold to, and further processed by, the formulator. Typically, this second level processing will involve only the addition of water, color and fragrance. Proprietary and/or therapeutic ingredients may also be added at this stage (*Appendix D*).

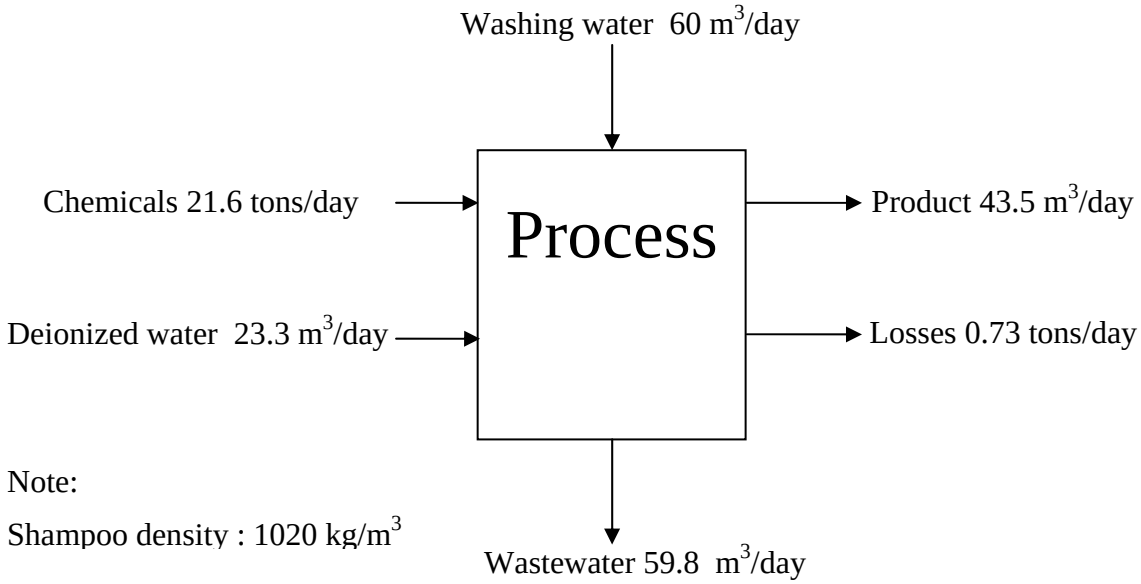


Figure 4- Mass balance diagram for shampoo production

Inputs:

- Chemicals = 21.6 tons/day
- Deionized water = 23.3 m^3/day x 1 tons/m^3 = 23.3 tons/day
- Washing water = 60 m^3/day x 1 tons/m^3 = 60 tons/day
- Inputs = 21.6 + 23.3 + 60 = 104.9 tons/day

Outputs:

- Product = 43.5 m^3/day x 1.02 tons/m^3 = 44.37 tons/day
- Waste water = 59.8 m^3/day x 1 tons/m^3 = 59.8 tons/day
- Outputs = 44.37 + 59.8 = 104.17 tons/day

Material balance:

Inputs = Outputs + Losses
104.9 tons/day = 104.17 tons/day + Losses
Losses = 0.73 tons/day
Percentage losses = 0.73/104.9 = 0.7%

3. Waste Treatment Practices

Nurture Shampoo Manufacturing produces only hair care shampoo with the capacity of 44m^3/day. As this factory is small, it produces fewer amounts of pollution, wastewater, solid waste, air pollution, and noise pollution.

In order to meet the Thai standard of wastewater effluent discharge, wastewater treatment plant was implemented. Wastewater is collected and mixed together from washing operation, cleaning, laboratory experiment, and domestic wastewater (Appendix D).

Air pollution is one of the problems found in this factory but it is not a big problem because fewer amounts of gas emission, NO_x, SO_x, dust and soot, and aerosol, is emitted to the atmosphere. All gases coming from the factory are treated by using wet scrubbers and bag house filters.

Solid waste is another pollution factor in the factory. Most of the solid wastes are plastics, cardboards, bottles, and food waste and yard waste. The recycled materials such as plastic, bottle and cardboard are sold to recycling shop, and food waste and yard waste are collected by municipal solid waste collectors.

Beside these three main pollutions, noise pollution is also found within the factory. Noise almost comes from blending machine and filling machine. This problem is solved by putting these processes in a closed room and all workers have to use ear plugs or ear mufflers.

Table 2- Wastewater Characteristic

Parameters	Unit	Concentration
BOD	mg/L	350
COD	mg/L	700
TDS	mg/L	3000
TSS	mg/L	650
Alkalinity	mg/L	200
Oil and Grease	mg/L	120
pH	-	10
Total N	mg/L	50
Total P	mg/L	9
Color	mg/L of pt	700
Temperature	^oC	29

3.1 Wastewater

Wastewater refers to the water discharged after use which contains the characteristics as shown in table 2. Wastewater treatment plant consists of primary treatment, secondary treatment, and tertiary treatment (Appendix E). Moreover, sludge dewatering and disposal is also implemented.

3.1.1 Pretreatment

Coarse solid such as plastic, cardboard, paper must be removed from the waste effluents to reduce abrasion and prevent damage to pumps, piping and sludge dewatering equipment. For the wastewater of this shampoo factory, mechanical bar screens and Equalization & Neutralization are used for the operation. Equalization & Neutralization play an important role of storing wastewater coming from the processes in batch operation and adjusting the pH between 6.5 and 8.0 to prevent disturbance in secondary biological treatment systems.

3.1.2 Primary Treatment

The main objective of primary treatment in the factory is to remove the settleable portion of SS and oil & grease. Floatation process is used to separate solid or liquid particle and to concentrate biosolids. Among the three unit operations - dissolved air floatation, dispersed air floatation, cavitations floatation - dissolved air floatation is used which consists of dissolved air under a pressure of several atmospheres introduced at the bottom of the tank, scrapper at the bottom and skimmer at the top of the tank to collect all settleable solid and to remove all the floating matter (oil and grease).

3.1.3 Secondary Treatment

Secondary treatment is designed to remove BOD associated with dissolved organic material in the effluent and normally uses biological processes. The biological treatment process can convert much of the dissolved organic material in effluent to water, CO_2 or organic suspended solids and expected BOD removal is 70-95%.

Suspended growth biological treatment process is used here to treat the wastewater. The process consists of the following three components: (1) a reactor in which the microorganisms responsible for treatment are kept in suspension and aerated; (2) liquid-solid separation, usually in a sedimentation tank; and (3) a recycle system for returning solids removed from the liquid-solids separation unit back to the reactor. The excess sludge from the secondary sedimentation tank is collected to sludge thickener in order to increase the solid content for dewatering process.

3.1.4 Tertiary Treatment

The components remaining after primary and secondary treatment are residual SS, residual BOD, Color and some other trace elements. Tertiary treatment designed to remove these components is activated carbon adsorption. The main purpose of using the activated carbon adsorption is to remove the color of the effluent treated water for reusing to the cooling tower, fire fighting, floor washing, gardening, road cleaning, and GAC back washing.

3.2 Air pollution

Nurture Shampoo factory is a small manufacturer which is equipped with all modern facilities and new technologies. Therefore, air pollution is not a big problem in this factory. However, air pollution is found from the boiler, by using heavy oil, and weighting room. The pollution control devices are shown in Table 3.

Table 3- EOP Technologies for the Air Pollution Abatement

Processes	Air Pollution Control Device
Raw material preparation (Dust)	Dust collection system (bag house filter)
Utilities (Boiler)	Wet Scrubbers

3.3 Solid Waste

In the process of making shampoo, it will not have large quantity of solid waste. Mainly we have paper, cardboard and plastic from production process and the office and food waste from the canteen and yard waste from cleaning the garden. Paper, plastic and cardboard will separate from the waste and sell for recycling. The other solid wastes will be collected by the municipal solid waste collection system (Table 4).

Table 4- Solid waste generation

Source	Waste	Unit	Quantity	Management
Office	Paper and Plastic	Kg/day	10	Recycle shop
Operation	Cardboard and plastic	Kg/day	40	Recycle shop
Canteen	Food waste	Kg/day	65	Municipal collection system
Garden cleaning	Yard waste	Kg/day	5	Municipal collection system

3.4 Noise Pollution

Mainly in Shampoo production process, noise is produced by dissolve tanks, boilers, mixers and filling machines. This is not a big environmental issue. But if we consider the cosmetic industry where we have size reduction processes will produce much more noise than the shampoo production alone.

In our industry we have separated sound proof rooms to keep these units and for the workers we will provide personal protective equipments like ear plugs and mufflers.

4 Environmental issues related to shampoo production

No by-products are produced during the shampoo manufacturing process. Washing out the blending vessel and other washing purposes will produce an effluent which will contain some shampoo. Since all reputable manufacturers of these products use fully biodegradable surface active agents, we use biological treatment process after removing oil and grease.

'Treated water' using newest inventions like titanium micro-dispersion water technology can be used for various cosmetic materials instead of normal demineralized water. This method produces high-function cosmetic materials offering the efficacies of active ingredients contained in the cosmetic material as well as the effects of titanium micro-dispersion water. But in our process we are using deionized water as the solvent media.Following are some of the Environmental Issues we found out in Shampoo manufacturing industry.

Air pollution: Mainly in shampoo production process we have air pollution due to NOx, SOx, and particulate matter and vapor. NOx is produced from the furnace and SOx and vapor from the fuel which is used to heat the boiler. Dust and soot is produced in the mixing units and the packaging area.

NOx and other emissions from the furnace will be absorbed by the packed tower which is connected to the furnace whereas we have implemented SOx reduction technologies like Dry Flue Gas Desulfurization Processes (FDG).

In the manufacturing process of shampoo we experience odor problems due to the chemicals which we use in the production process. We can not eliminate the odor problem and we use a dilution method as these odors are non toxic. In our industry we provided more ventilation for the areas where we have these production units and for workers we provide personal protective equipments like dust masks and respirators.

Noise pollution: As mentioned earlier, noise is produced from dissolve tanks, boilers, mixers and filling machines. Noise pollution may be significant if we consider cosmetic industry as a whole.

Water pollution: The major pollution source is the waste water coming from the production process. It contains lot of colloidal particles and the spilling of the raw materials. Floor cleaning waste water also comes to the wastewater treatment plant. We try to minimize the wastewater amount generate in the production process by implementing CIP (Clean in Place) as much as possible. As a newly constructed industry our machines like mixers and filling units we have this technology. We will not be going to reuse the raw materials which are coming as waste.

In wastewater TDS content is considerably high, because we have lot of colloidal particles in the wastewater. In general Cosmetic industries contain high TDS values. And also the incoming wastewater contains lot of forms. When we adjust the pH of the incoming wastewater in the equalization tank, we can make this issue to minimum.

Adjusting the pH is a must in our treatment process because we are going to use biological treatment process to remove BOD. Waste water coming out of the production process will have a higher pH value because we use some basic solutions as our raw materials. (Eg. Caustic)

Solid wastes: We do not get large quantity of solid waste from the process. Mainly we have paper, cardboard and plastic from production process and the office whereas food waste from the canteen and yard waste from cleaning the garden. Paper, plastic and cardboard will be separated and sold for recycling. The other solid wastes will be collected by the municipal solid waste collection system.

5 Cleaner Production

Cleaner production is the main tool to reduce the pollution from industries which applies integrated preventive strategies to processes, products and services to increase economic efficiency and to reduce risks to humans and environment.

Cleaner production means economic savings from reduced consumption of raw materials and energy, and lower treatment costs, as well as other benefits such as a better company image and better working conditions. Implement cleaner production may not solve all environmental problems at a facility, but it will decrease the need for installing and operating end of pipe treatment equipment and reduce the quantity of hazardous waste that must be treated and disposed of.

Following are some of the aspects addressed as cleaner production approaches.

Process modification: When environmental issues becomes more important, shampoo manufacturers care about non-polluting materials such as organic ingredients (saponin extracted from pods of Acacia aulucumiformis), biodegradable bottles. Shampoo bottles made from beet extracts that biodegrade in compost pile, or fabrics that break down in soil safely, without any toxic by-products.

As a new industry we have the best available technology in the present days. Most of the machines are run by computer softwares which will give accurate measurements on batching and mixing of ingredients. This will lead to optimum raw material usage.

Recycling: In the boiler water will be recycled and use it back. We need to supply what ever the amount we loose due to evaporation losses. For the Cooling tower we plan to use the treated effluent. And that will be used in floor cleaning, fire fighting, road cleaning and gardening purposes.

Dust Control: Dust and soot can be controlled using bag filters or wet scrubbers. Unloading the raw material will be one of the dust generating points. By directly unloading the raw material in to the storage silos will reduce the dust generation.

Noise reduction: Even though this is not a big issue in Shampoo production, we have a plan to do regular checking of noise generated by the machine units. We will maintain the machines according to the guidelines provided in Occupational Safety and Health Administration (OSHA) specification.

Raw Material quality will also be monitored and changed accordingly to achieve optimum conditions.

Solid waste management: Segregation of solid waste will be promoted as an essential part of the process. Especially plastic, paper and cardboard will be separated from other solid wastes and sell to the recycling shop. Plastic bottles from the quality assurance unit will be washed and reused.

6 Pollution Norms

Pollution norm is used to compare the pollution loading from the actual practice to the standard or guideline. For shampoo production, there is no specific pollution norm in

the WHO guideline. Therefore, we compare the pollution load of our production with some of the soap production processes given in WHO guideline as shown in table 5.

Table 5- Typical Pollution Norms for Soap Production

	Unit [U]	Waste Volume [m^3/U]	BOD5 [kg/U]	TSS [kg/U]	Oil [kg/U]
Soap from kettle boiling	tn product	4.5	6	6	0.9
Liquid Soap	tn anhydr	-	0.1	0.1	0.1
Liquid Detergent	tn anhydr	-	2	-	-

Table 6- Wastewater Pollution Load

Parameter	Flow [m^3/day]	Unit [U]	Flow [m^3/tn]	BOD [Kg/tn]	COD [Kg/tn]	TSS [Kg/tn]	0il [Kg/tn]
Pollution load	110	tn product	2.5	0.875	1.75	1.625	0.3

7. Case study – Unilever Thai Holding Ltd.

7.1 Introduction

Unilever is a part of Thai people's lifestyle. It has penetrated deeper not only into their culture but also in the commercial market within a span of 70 years in the country. So far, as they claim, Unilever's products have been the most sold items in Thailand market.

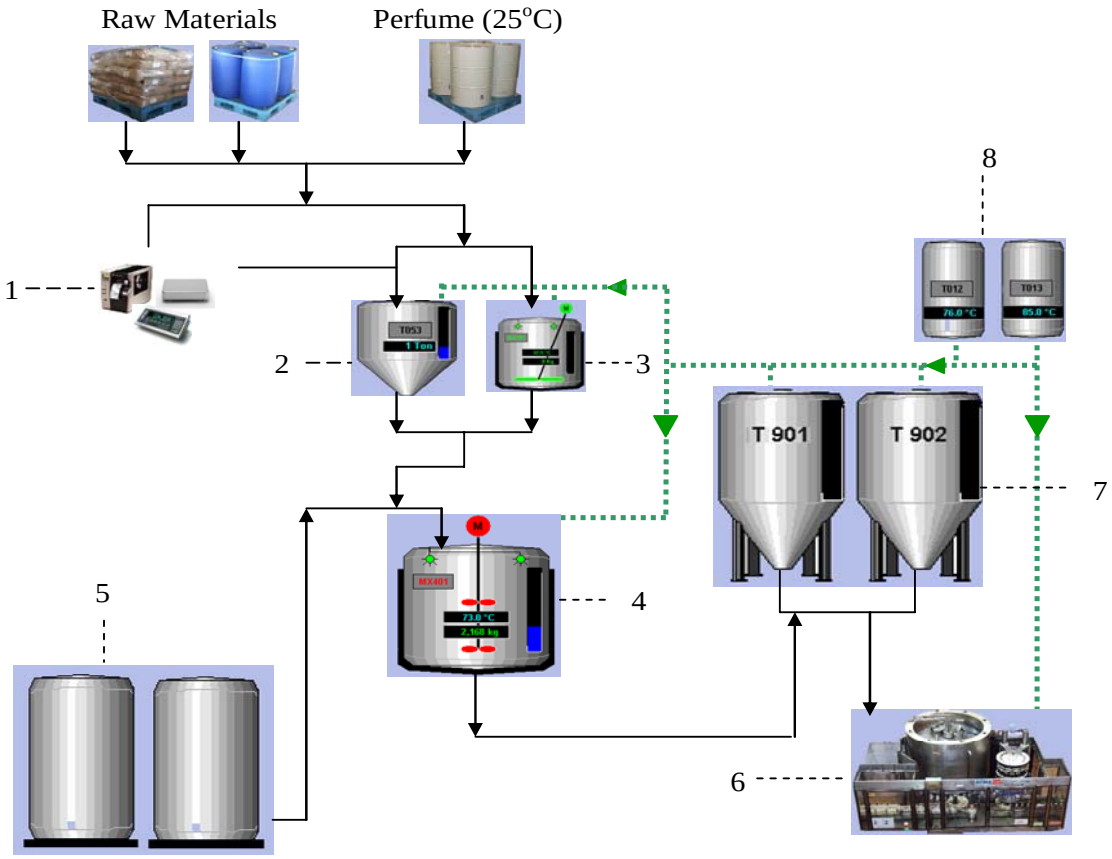
Currently, Unilever has about 3000 professionals in their factories located at various parts of Thailand. Their products range from food products, cleaning products, garment products and others that fulfill every demand of Thai lifestyle. The company's vision is "to respond every demand with new products".

Shampoo products from Unilever were introduced in Thailand in 1976 with brand names of "Clinic & Clear" and "Sun silk". They have been the trade leaders in Thailand for the past 30 years or more. Product categories include anti-flat, anti-proof, straighten-up, etc.

7.2 Shampoo process

Shampoos are produced by mixing all ingredients (Figure 5). Raw materials must be prepared and weighed by weighing machine. Then they are mixed in bulk material mixer at approximately 80^{o}C. Some components vaporize easily such as perfume so that they need to be mixed separately at lower temperature of 25^{o}C in side mixer.

After premixing, ingredients are mixed properly in main mixer at about 32°C. After that, the liquid is transferred to storage tanks before being filled into bottles or refill bags. When production batch completes, machines are cleaned by hot water at 80°C.



1. Pre-weight station
2. Bulk mixer
3. Side mixer
4. Main mixer
5. Bulk material storage
6. Filling machine
7. Storage tank
8. Clean in place unit

Figure 5- Shampoo process flow diagram

7.3 Wastewater management

Waste water of shampoo production in Unilever Thai Holding Ltd. varies in pH values (Table 7). Flow rate is of 4,500m^3/day. Treatment includes physical-chemical processes as well as biological process as shown in figure 6.

Table 7- Waste water characteristic of Unilever Thai Holding Ltd.

Parameter	Influent	Effluent	IEAT Standard
1. pH	5.8 – 11.5	7 – 8	6 – 9
2. BOD (ppm)	3,243 – 5,035	15 – 50	500
3. COD (ppm)	4,849	30 – 150	750
4. Oil & Grease (ppm)	61 – 202	< 10	10
5. Suspended Solid (ppm)	492 – 1,635	< 50	200

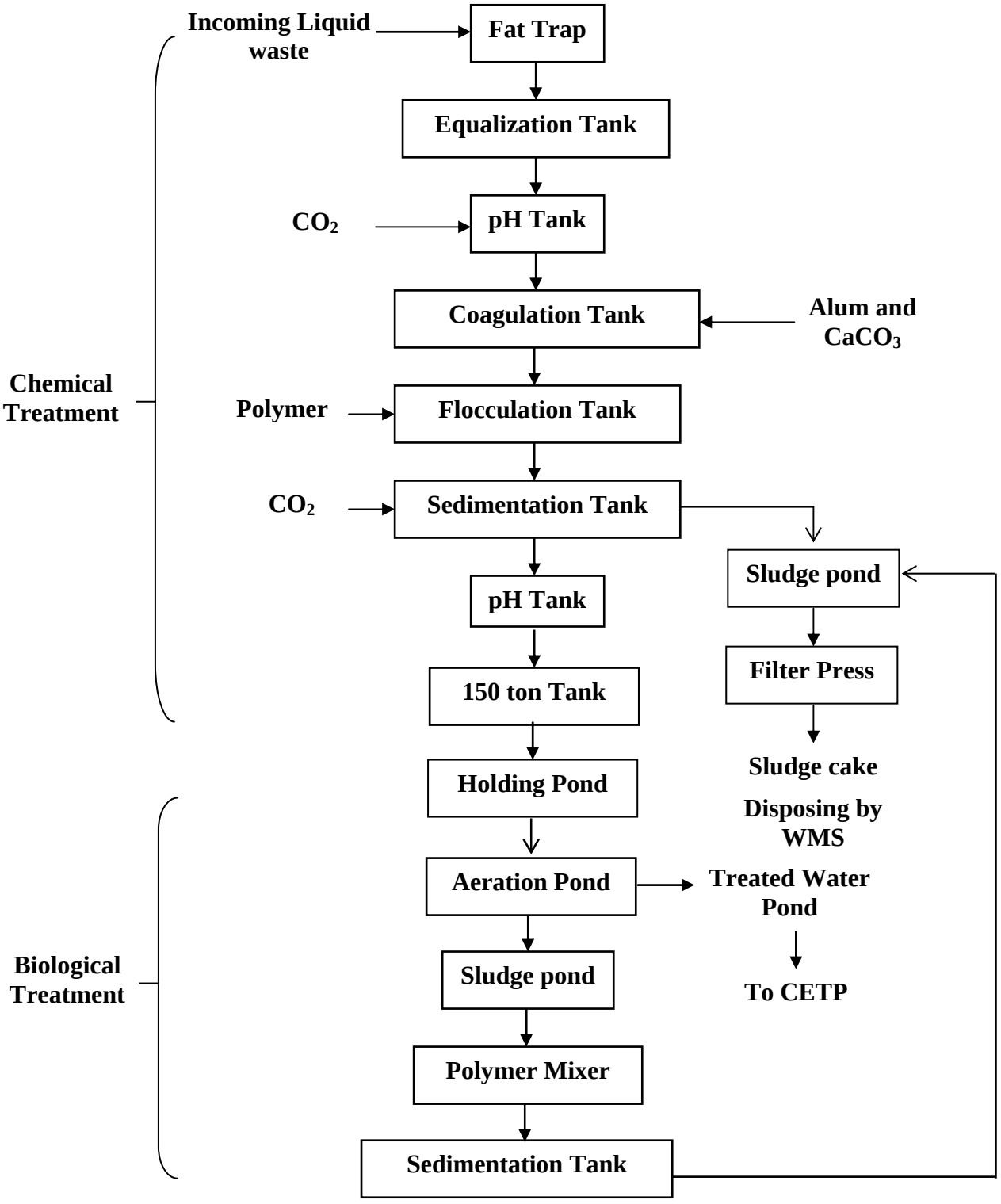


Figure 6- Wastewater flow diagram

7.4 Solid waste management

7.4.1 Type of solid waste

a. Paper i.e. box, casket, office paper, etc.
b. Plastic i.e. plastic bags, sheath, bags to put raw materials, etc.
c. Hazardous waste i.e. batteries, fluorescent bulbs, spray bottles, etc.
d. Common waste i.e. yard, food waste, etc.

7.4.2 Waste management

a. Waste for sell consists of paper, plastics, metal container, metallic scrap and oil waste. Annual revenue from waste selling is of 1.7 million Bath.
b. Waste for disposal by incinerator consists of scrap common waste and hazardous waste. Disposed waste annual expenditure is 1.8 million Bath.

7.4.3 Waste collection

Waste collected to landfill site includes scrap hazardous waste which consists of chemical contaminated container i.e. canned, fluorescent bulbs, used oil etc. Layout of waste collection zone is shown in appendix F.


Figure 7. Waste collection

a) Contaminated container; b) Waste collection and recycle process

a. Compression

Waste from residue raw materials; wrapping up plastics, detergent, scrap of paper etc. are compressed as shown in figure 8.


Figure 8. Compression solid waste

b. Incineration

After waste separation, they will divide waste 2 groups consisting of recycle waste and un-reusable waste. The latter will send to incinerator inside factory or landfill outside factory.

c. Transportation

Rubbish is both compressed and loose waste by using container as shown in figure 9.


Figure 9. Waste collecting truck and transportation

d. Contaminated container

- Plastics tank size 200 L, metal tank size 200 L, fiberite and carton, used oil etc.
- Revenue from contaminated container is around 1,700,000 Bath/annual.

e. Waste disposal

Waste disposal process selected in Unilever company have two ways are compound of incineration which is situated in factory and other wastes not be able to burn going to landfill to be buried.

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Appendix A

Market Potential for Hair Care Shampoo in Asia (US $ mln): 2005

Country	Latent Demand US $ mln	% of Asia
China	796.18	33.74
Japan	539.30	22.85
India	385.47	16.33
South Korea	135.94	5.76
Indonesia	113.92	4.83
Thailand	71.73	3.04
Taiwan	67.73	2.87
Philippines	53.68	2.27
Malaysia	39.69	1.68
Bangladesh	35.45	1.50
Hong Kong	32.34	1.37
Vietnam	26.99	1.14
Singapore	19.62	0.83
Burma	11.10	0.47
Sri Lanka	10.96	0.46
Nepal	5.84	0.25
North Korea	3.69	0.16
Cambodia	2.79	0.12
Papua New Guinea	2.11	0.09
Laos	1.56	0.07
Macau	1.34	0.06
Brunei	1.02	0.04
Mongolia	0.80	0.03
Bhutan	0.40	0.02
Maldives	0.10	0.00
Other	0.10	0.00
Total	**2,359.86**	**100.00%**

Source: www.icongrouponline.com

The Market for Hair Care Shampoo in Asia: 2000 -

Year	US $ mln	% of Globe
2000	2,534.52	33.14
2001	2,487.84	32.73
2002	2,423.90	32.38
2003	2,353.82	32.06
2004	2,307.42	31.80
2005	2,359.86	32.04
2006	2,430.69	32.36
2007	2,504.11	32.68
2008	2,580.21	33.00
2009	2,659.10	33.33
2010	2,740.90	33.66

Hair Care Shampoo (US $ mln): Thailand 2000 - 2010

Year	Thailand	% of Region	% of Globe
2000	75.33	2.97%	0.98%
2001	74.51	3.00%	0.98%
2002	73.14	3.02%	0.98%
2003	71.54	3.04%	0.97%
2004	70.51	3.06%	0.97%
2005	71.73	3.04%	0.97%
2006	73.35	3.02%	0.98%
2007	75	3.00%	0.98%
2008	76.69	2.97%	0.98%
2009	78.42	2.95%	0.98%
2010	80.19	2.93%	0.98%

Source: www.icongrouponline.com

Appendix B

Thailand: Hair Care Shampoo in 2005, US $ mln

City	World Rank	US $ mln	%Country	%Region	%World
Bangkok	14	66.78	93.11	2.83	0.91
Chon Buri	435	2.48	3.46	0.11	0.03
Songkhla	933	0.76	1.06	0.03	0.01
Nakhon Ratchasima	1,150	0.45	0.63	0.02	0.01
Chiang Mai	1,167	0.44	0.61	0.02	0.01
Khon Kaen	1,217	0.39	0.55	0.02	0.01
Nakhon Si Thammarat	1,361	0.28	0.4	0.01	0
Phitsanulok	1,629	0.12	0.17	0.01	0
Hat Yai	1,966	0.02	0.02	0	0
Total		**71.73**	**100**	**3.04**	**0.97**

Source: www.icongrouponline.com

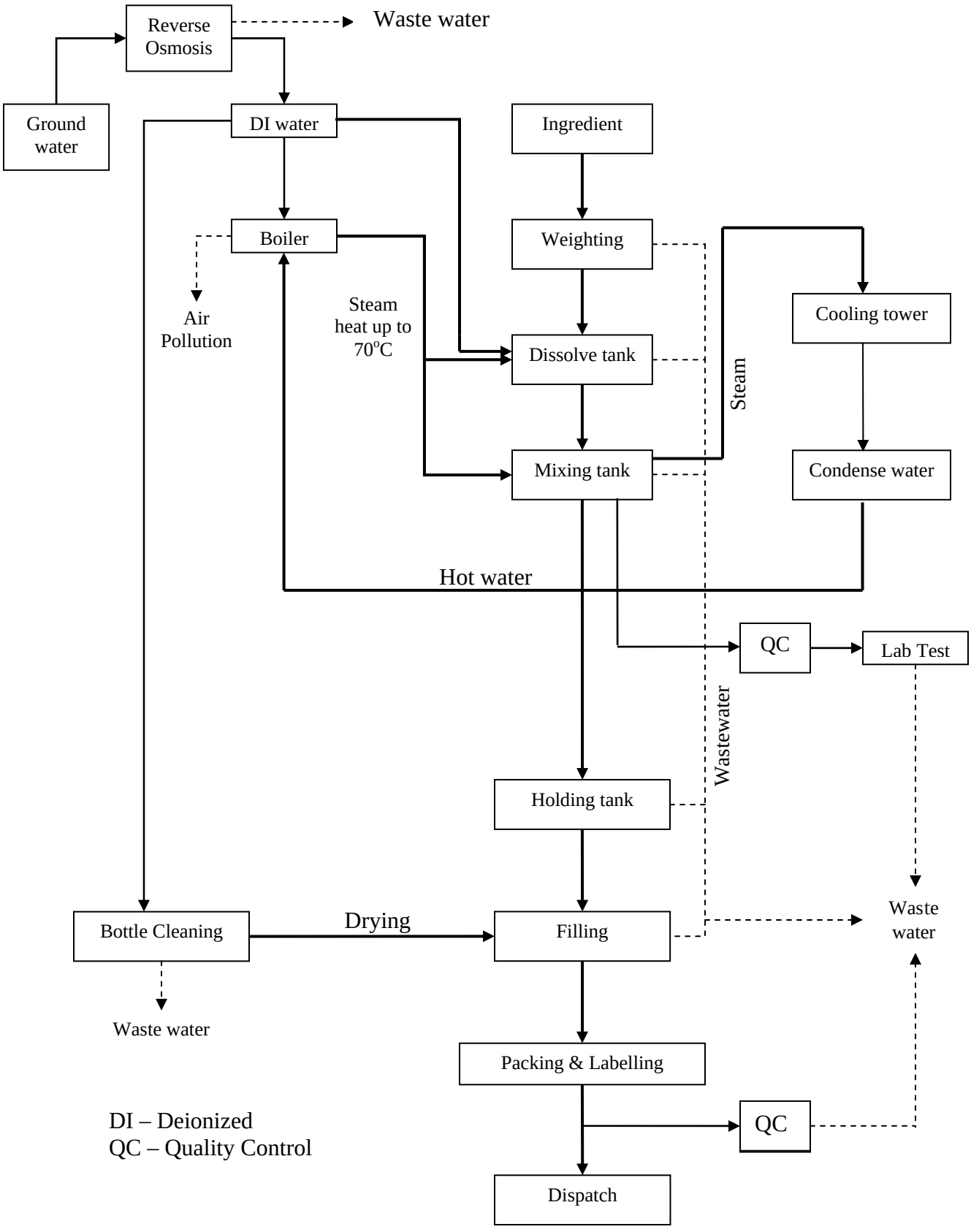
Appendix C

Raw Materials

Chemical Name	***Trade Name***	***Quantity Day (Kg)***	***Purpose for which it is used***
PEG-150 Distearate	STEPAN PEG 6000 DS	244.4	To increase the viscosity
Sodium Laureth Sulfate	STEOL CS-230	8,976	Surfactants are surface active ingredients, meaning they can interact with a surface
Disodium Cocoamphodiacetate	AMPHOSOL 2C	8,976	To improve the foaming characteristic.
Cocamidopropyl Hydroxysultaince	AMPHOSOL CS-50	2,692.8	To improve the foaming characteristic.
DL-2,4-Dihydroxy-N-(3-hydroxypropyl)-3,3-dimethylbutyramide, Butyramide	Panthenol	22.4	To modify these characteristic, manufacturers add fragrance and governmentally approved.
Citric acid	2-Hydroxy-1,2,3-propanetricarboxylicacid	112.2	To adjust pH
Sodium hydroxide	Caustic Soda	112.2	To adjust pH
Sodium chloride	Salt or Sea salt	112.2	To adjust viscosity
-	Orange blossom 600	112.2	To add smell aromatic
4-(2-Hydroxy-1-naphthylazobenzenesulfonic acid, Sodium salt)	D & C Orange No.4	244.4	To modify characteristic, adding dye.
Benzoic acid, 4-hydroxy-,propyl ester	Propylparaben	22.4	To preserve

Appendix D

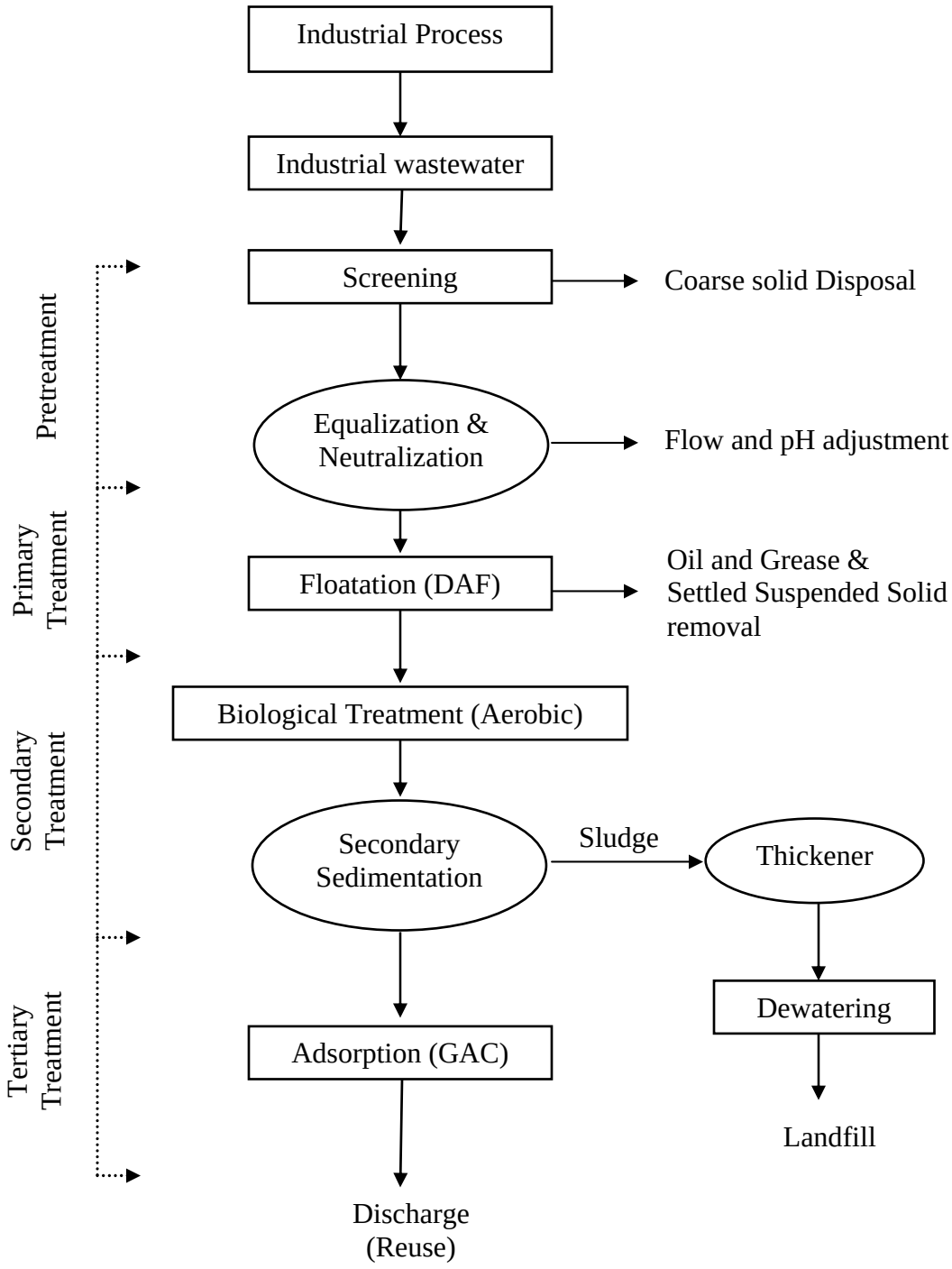
Processes Diagram

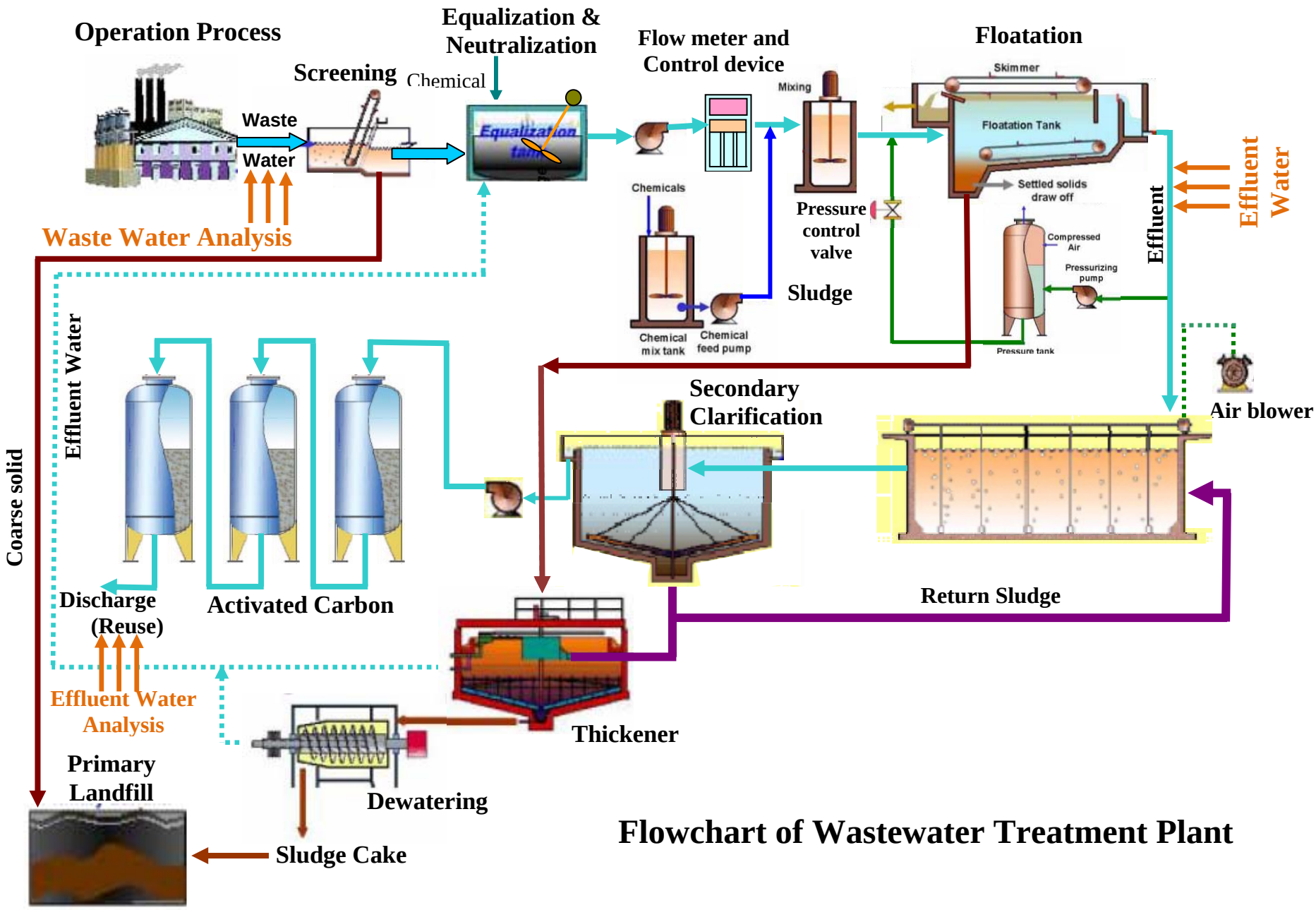


DI – Deionized
QC – Quality Control

Appendix E

Wastewater Treatment Flow Chart





Flowchart of Wastewater Treatment Plant

Appendix F

Figure G: Layout of Waste management Unit