CHAPTER 5.0 GENERAL DISCUSSIONS

Waste auditing conducted in Cognis Oleochemical (M) Sdn. Bhd. involved the investigation of major operations that produce waste. The auditing steps contributed information in the evaluations towards waste minimization by identifying waste stream that requires most attention based on composition, quantity, disposal cost, degree of risk, minimization possibility, recyclables and status of compliance (Haas, 1995).

Information from the waste audit conducted at four major locations, which included the Flaking Plant (Lot 1), Technical Division, Administration buildings, and the cafeteria indicated various possibility of waste reduction and reutilization. Reduction of waste can be conducted by replacing appropriate items with materials, which can be reused and last for a longer period. All disposable items such as gloves, mask, and tissue paper must be minimized to the smallest quantity possible to reduce waste generation and reduce the utilization of natural resources.

In the Flaking Plant, waste reduction can be carried out by: maintaining good housekeeping to avoid excessive waste generation during cleaning process; conducting regular machinery maintenance to prevent breakdown, and reduce inefficiency in production; preparing good plan to increase and maintain efficiency, prevent spillage of product and chemicals; always have good communication with marketing department to avoid rebagging of products; replacing wooden pallets with high durable plastic pallet to

reduce pallet damage; and encouraging customers to return pallet to cut cost and reduce waste. All staffs In the Flaking Plant should dispose the wastes in their appropriate containers to optimize recycling possibilities. Also, employees should be encouraged to segregate off-spec products and product spillage into containers according to the level of foreign materials present, to enhance the recycling of the items according to its purity.

In addition to waste reduction, reuse of waste should also be implemented to avoid disposal of waste unnecessarily and to reduce the use of natural resources particularly from the non-renewable sources. The Flaking Plant should reuse bags generated from the rebagging process for other storage purposes by putting some effort to avoid damages on the bags during reopening and rebagging processes. Employees should be encouraged to repair broken and damaged wooden pallets. Also, metal drums should be reused to store liquid waste, scheduled waste and product residue to reduce utilization of fresh bags for storage purposes

In the Technical Division, waste generation can be reduced by: avoiding the usage of disposable latex gloves where possible and replace it with highly durable and long lasting rubber gloves; avoiding taking extra chemical /reagents from bottles for chemical analysis but instead practice efficient usage of chemicals and reagents; plan efficiently when conducting chemical analysis to avoid spillage and damage of tools; conduct regular maintenance to avoid machinery breakdown, repair and replacement; avoid disposing non-scheduled waste into scheduled waste container; discourage utilization of tissue paper and paper towels for cleaning purposes, replace with cotton towels;

encourage optimum usage of paper, e.g. printing internal documents on both sides of paper; and maintaining good housekeeping to avoid excessive waste generation during cleaning process.

The staffs in Technical Division should use both sides of paper for photocopying and printing draft copies work, by placing a tray beside the photocopy machine for one-sided paper that can be reused. Also, the division should introduce special envelopes and reuse the envelopes for internal circulations whenever possible. The staffs and personnel in the premise should also be encouraged to reuse suitable reagent containers as storage containers for product sampling and analysis.

In the Technical Division, all employees should be encouraged to recycle all recyclable items including paper, food wastes, and plastic. Also, the staff should be encouraged to use environmental friendly items to avoid hazardous exposure, whenever possible with efficient planning to optimize recycling possibility.

The staff and personnel in the Administration buildings can conduct waste reduction by practicing optimum usage of paper by printing on both sides of the paper whenever possible, refilling of ink in computer printing cartridges instead of changing the cartridge, and rechecking and previewing documents before printing to avoid unnecessary paper waste. Inter-office envelopes, preferable with window should be introduced for internal usage to prevent unnecessary waste generations. Also, reutilization of paperclips and file folders should be practiced to avoid disposal of usable items as well as practicing litter

less lunches. In pantry room of the Administration buildings, reusable utensils, e.g. mugs, spoons and forks, should be provided to avoid utilization of disposable utensils.

In the Administration buildings, there should be adequate recycling receptacles throughout the building with appropriate labels and signs. Also, office activity should use material with recycled content. All employees should be encouraged to have recycling container next to their desk to store recyclable items and to give their full cooperation towards the recycling program and cooperate in segregating the waste.

In the cafeteria, to promote waste reduction programs, customers should be encouraged to purchase food prepared in the canteen instead of packed food to reduce food wrapper wastes, to use washable napkins and avoiding food wastage, and to discourage customers to take-away food to avoid packing material waste. The cafeteria personnel should participate in the program by replacing the usage of disposable plastic bags and paper in delivery process with suitable reusable/returnable delivery containers, purchasing regular ingredients required for food preparations, in large quantities to reduce disposal of smaller food ingredients containers and to maintain good housekeeping in avoiding excessive waste generation during cleaning process and to reduce disposing of expired food. Meanwhile, the cafeteria staff should encourage customers to purchase take-away food in returnable containers while the cafeteria personnel can reuse suitable containers for food storage and other purposes.

The cafeteria must have adequate recycling containers throughout the premises to encourage the recycling of paper, metal, glass and plastic waste by having a person assigned to the responsibility of collecting the recyclable items. Customers should be encouraged to segregate their leftover into appropriate containers as provided, to set up a backyard-composting unit on the ground with post signs for staff informing them of the acceptable materials.

Information from the waste auditing indicated that there are two main components of waste generated by the industry, which included the wastewater sludge and the glycerol residue. Both wastes require more than RM 0.4 million for management and disposal costs, particularly the glycerol residue that is classified as scheduled waste and required special treatment and disposal.

Due to high percentage of organic content in both waste, biological treatment seemed to be the best solution towards waste management. The determination of the waste characteristics were conducted to plan for the best biological treatment particularly, composting. Individual constitutive elements of the compost are essential in order to design and plan the appropriate ratio and capacity of the composting (Diaz *et al.,* 1993). Biological analysis conducted on both wastewater sludge and glycerol residue showed that only wastewater sludge had its' indigenous bacteria, while glycerol residue had none. Therefore, in order to carry out composting, microorganisms must be introduced to enhance the process.

The preliminary composting trial indicated the possibility of wastewater sludge to undergo composting process with and without additives, while glycerol residue could not be composted even with the addition of chicken manure, garden waste, soil, urea or wastewater sludge. The biodegradation of glycerol residue was inhibited due to the high alkalinity and high salt content of the material.

The second composting trial was conducted by concentrating the introduction of microbes that can adapt in high salinity environment, through the addition of mangrove soil into glycerol residue. Glycerol residue was added in lower percentage in the wastewater sludge with goat manure combinations to see the composting result through pH reduction. The negative results of glycerol residue in high percentage in compost showed that glycerol residue could not be composted even with the introduction of high tolerant microbes, but composting can occur when it was added in small percentage in compost combination. However, the introduction of glycerol residue in the compost combination is found to inhibit fungal growth as indicated in the microbiological analysis even though composting took place in a very slow pace. The presence of both bacteria and fungi will allow the composting process to accelerate (Spellman, 1997), which showed the reason why the composting rate of wastewater sludge and goat manure with glycerol residue dropped.

Third composting trial was carried out by focusing the composting of wastewater sludge with various additives including sewage sludge, goat manure, spent grain, and soil. Results showed that wastewater sludge was best composted with the addition of goat

manure, sewage sludge and soil. The trial also indicated that the presence of as much as 14 % will inhibit microbial growth from the results of wastewater sludge, sewage sludge and 14% glycerol residue composting.

Data obtained from the three composting trials indicate that the wastewater sludge can be composted by itself with some mixing process during the first two weeks of the composting period. The addition of additives acted as extra microbial source to accelerate composting process and helped to reduce the moisture content of the wastewater sludge. In the case where composting material have a moisture content exceeding 80 %, dewatering and the addition of bulking agents are required, which directly affects the composting process and the quality of the final product (Metcalf & Eddy, 1991). Also, in order to produce better quality compost, goat manure and soil addition are preferable to increase nutrient content in the final composting product, particularly for commercialization.

The application of fertilizer to plants requires appropriate ratio to avoid excessive nutrient supply, which making the planting medium unsuitable for growth (Miller and Jones, 1995). Applications of 10%, 50% and 100% of compost were conducted to test the possibility of using the compost for planting. Data obtained from the planting trials were tested with two-way ANOVA and the results indicated that plants grew in treated growth medium of compost 2 from wastewater sludge (WWS), and goat manure (GM), compost 4 from WWS, sewage sludge (SS) and soil, and compost 6 from WWS, GM and glycerol residue (10:10:1), produced better crop in terms of weight compared to soil treated with

inorganic fertilizer. Significantly higher height increment were shown from plants treated with compost 4, compost 5 from WWS, SS and spent grain, and compost 6 while plants treated with compost 2, compost 4, compost 5 and compost 6 showed a significantly higher number of leaves of the crops, compared to plants grew in soil without additive and plants with inorganic fertilizer. This indicated that compost is more suitable as growing media with the good texture and water-holding capacity (Miller and Jones, 1997). Compost can also be used for other applications including soil remediation, pollution prevention, disease control for plants, erosion control, turf remediation and landscaping and sites restorations (USEPA, 1998).

The compost produced from the composting process of the wastewater sludge and various additives including the glycerol residue of the company can be commercialized to reduce waste management and disposal cost, as well as to generate considerable annual revenue of more than RM 0.45 million. Glycerol residue, which can only be composted in small percentage can reduce it's management and disposal costs with the reduction of glycerol residue for disposal.

Due to various factors, the study conducted had its limitation particularly by referring to the size of the composting trials and the time scale. With the smaller scale to suit the available facilities, the composting trials did not show satisfactory temperature increment. Also, due to time constrain, composting trials were only conducted with the mixture of the most promising combinations by referring to the known characteristic from preliminary trials. For further study, the scale of composting may be increased into a

larger scale to obtain a better temperature profile with higher temperature peaks meanwhile more possible combination of mixture can be tried to test the composting process of the wastewater sludge and the glycerol residue.

The composting process not only reduces the waste management and disposal cost but also improves the competitive quality of the company towards their commitment in achieving ISO 14 000 and become an environmental friendly industry