ABSTRACT

The utilization of renewable resources particularly from plant-based industries, such as, in the oleochemical sector makes it possible for further expansion of down-stream process products. However, to remain competitive the pollution generated from this industry should not be taken lightly. Implementation of cleaner technology into the oleochemical process will increase the efficiency of resource utilization of the industry, concurrently reducing quantity of waste generated.

Waste audit conducted at Cognis Oleochemical (M) (COM) Sdn. Bhd. indicated that the major process-wastes generated by the facility were glycerol residue (GR) from Cognis Rika (M) Sdn. Bhd. (CRM) and wastewater sludge (WWS) from COM wastewater treatment plant; the daily production was 1.0 tonne and 3.0 tonnes, respectively. Besides GR, which is classified as scheduled waste, the process operations also generated 1.17 tonnes/day of other hazardous wastes including spent chemicals and contaminated items. Currently, 65% of the total waste generated by COM is recycled and reused within the premises. Waste paper from Administrative center was 21.17 kg/day while plastic waste generated was 1.71 kg/day. The percentage of recycling and reuse options can be increased with the implementation of appropriate reduction, reuse and recycling programs.

Based on the waste audit data, it was established that WWS and GR were the principal wastes, and experiments were conducted to investigate the possibility of composting

WWS and GR generated by COM as both wastes contained high percentage of carbon at 94 % and 18 %, respectively. The moisture content of the WWS was more than 86 % while GR contained less than 5 % moisture. The C/N ratio of both wastes ranged from 23.9 to 26.2. Total phosphorous in WWS and GR were 3.5 % and 1.44 %, respectively. WWS contained 76 ppm of magnesium, while GR contained 149 ppm. Potassium content in WWS was lower (0.7 %) than in GR (7.68 %). Microbial analysis on both wastes indicated that the WWS contained at least six types of bacteria and two types of fungi, while GR was free of microorganisms indicating that to enhance biological degradation of GR, microbes or additives would have to be introduced into the residue.

Three composting trials were carried out using WWS and GR with various additives such as urea, soil, garden waste, chicken manure, goat manure (GM), mangrove soil, sewage sludge (SS) and spent grain (SG). The first composting trial showed that WWS with chicken manure composted with temperature increase up to 55°C. WWS can also undergo composting even without additives, due to the presence of its' indigenous microbes. GR, with very high alkalinity (pH 10-12) and high salt content, ranging from 30% to 60%, did not undergo composting when it was added with additives such as chicken manure, garden waste, soil, urea or the WWS. The second composting trial indicated that GR hindered composting process even with the introduction of mangrove soil as the source of high salinity-tolerant microbes. However, when GR added was below 4 %, composting was possible but at a very slow rate.

The third composting trial ,showed that addition of GM, SS and soil can speed up the composting of WWS to less than 7 weeks compared to 9 weeks for the control WWS without additives. The C/N ratio of the composts produced in the third trial at the final week (week 9), ranged from 13.0 to 33.2, while the initial C/N ratio was 27.2 to 57.4. Microbial analysis conducted showed that there were at least three types of microorganisms in every compost treatment except compost with the combinations of WWS + sewage sludge (SS) + GR, which showed no sign of microbial growth.

Application of the compost generated from the second and third composting trials to Chinese mustard (*Brassica* sp.) showed that the compost enhanced leaf production from 12% to more than 500% compared to inorganic fertilizer at the same total nitrogen level. The plants from the 50% soil plus 50% compost combinations of WWS, WWS + GM, WWS, SS + soil, WWS + SS + SG, and WWS + GM + GR, gave 9.85 % to 84.43 % higher fresh weight compared to control (100% soil or soil + inorganic fertilizer). Also, result obtained showed that composts derived from two treatments: WWS + GM and WWS + SS + soil, can act as a good growth medium for Chinese mustard. The compost has commercial potential with a gross profit of RM 424.00 per tonne at current market price for organic fertilizer, while waste management and disposal costs could be reduced by as much as RM 150 per tonne of wastewater sludge, giving a combined advantage of RM 630 per tonne (US$ 151.24 per tonne) of wastewater sludge.