ANAEROBIC TREATMENT OF HOG WASTES IN SUBTROPICAL REGION.

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There is a variety of methods available for hog manure treatment. Traditional aerobic methods such as active sludge and oxidation ditch are no longer affordable by hog farmers after the world energy crisis due to high cost of equipment investment and operation maintenance. Anaerobic treatment usually involves two methods - anaerobic lagoon and anaerobic fermentation. Although the cost of equipment and manpower are extremely low, the operation of anaerobic lagoon would require vast land and often result in underground water contamination. As the result of production of methane gas as a useful fuel during the process of anaerobic fermentation, the application of this method has been reassessed after world energy crisis.

The merits of anaerobic fermentation (McCarty 1964) involves; (1) a high degree of waste stabilization, (2) low production of waste biological sludge, (3) low nutrient requirements, (4) production of methane as a useful end product, (5) no oxygen required; although there are some pitfalls of the method involved such as the limitation of temperature and the slow growth rate of methanogens. Besides, anaerobic fermentation can be used to treat extremely high concentration of wastes. Simplicity in operation and management, as well as low cost have attributed to the advantage of anaerobic treatment over aerobic methods. Undoubtedly, anaerobic fermentation is affected by temperature, but its operation influence is widely spread in this case, ranging from 5 to 60°C. Because of warm weather in subtropical region, the treatment of swine wastes can be operated successfully even in winter. If there are some types of insulation apparatus or keeping-warm facilities attached to the fermentater, or alternatively if the fermentater is laid underground to eliminate its spacing on the ground surface and to decrease temperature flucturation as influenced by the outside environmental conditions, there would result in increasing efficiency of overall fermentation process with shorter retention time and less the required fermentation volume.

Red mud plastic (RMP) material developed in 1974 by Union Industrial Research Lab., Taiwan (UIRL) has been successfully used to construct fermentater for the experiments of anaerobic fermentation of swine manure conducted by Taiwan Livestock Research Institute. Up now, RMP fermentater is gradually being accepted by Taiwan hog farmers to replace the old one of water-seal type made of red brick and cement. RMP fermentater has been manufactured and exported to more than 20 different countries.

The primary ingredients of RMP material consist of red mud and the wastes from aluminum processing plant. It is an excellent material resistant to acid, alkaline, salt and ultraviolet light. According to aging test results conducted by UIRL, a RMP sheet of 1.2 mm thickness could last for more than 20 years.

RMP fermentater resembling as a sausage, is a bag of long horizontal type. Approximately 4/5 to 3/5 of its lower volume lying underground to hold hog manure is used as fermentation portion, while the remaining upper portion of the bag exists as air space. At both ends of the bag show inlet and outlet tubes made of PVC. Both tubings must be immersed into the fermentation portion of the bag to prevent the escape of methane gas from the fermentater. Also in the air space portion there is a gas tube leading methane to the place where it is to be utilized.

The Biochemical Oxygen Demand (BOD) of the effluent from RMP fermentater for 15 days hydraulic retention time is usually less than 200 ppm. But the effluent still consists of abundant nutrients especially in high nitrogen source that can be further utilized as either organic fertilizer in irrigation system or culture medium for high-protein Spirulina production. The application of the effluent for algae cultivation not only can produce algae for animal feed but also can achieve a second-treatment facility to further improve the standard of swine drainage water.

In the beginning of algae culture, water is initially introduced to the pool up to about 16 cm deepth, then a 4 cm deepth of concentrated algae fluid with optical density (OD) higher than 1.0 is transplanted. Spirulina concentration after transplantation is normally ranged between 0.1 to 0.2 OD. To maintain normal growth of Spirulina, it is necessary to add the effluent to algae pool daily. The amount of addition depends on NH_3-N conc. in it. Too high conc. of NH_3-N would yield toxicity to algae, but too low conc. would result in lack of nitrogen source leading to the retardation of algae normal growth. Optimum NH_3-N conc. added to culture medium is found to be 20 ppm (Chiu et al, 1979). If NH_3-N conc. is over 50 ppm, Spirulina growth appears to be retarded. There appears no survival of Spirulina at all if NH_3-N conc. is over 100 ppm. Usually it would take about 2 weeks for Spirulina to grow from its initial conc. of OD 0.1-0.2 to 1.0 which is considered ready for harvest. The yield is about 7.3-9.7 g. dry weight per M^2 pool area per day.

The fermentation effluent is abundant in various nutrients but lack in carbon source due to the fact that most of it in hog manure has been converted to CO_2 in the biogas after anaerobic fermentation. The availability of carbon source nutrient in fermentation effluent thus becomes a limiting factor for algae protoplasm synthesis. Right now, an experimental design has been undertaken to allow complete mixing of the biogas produced and the liquid used in the algae pond. This would not only eliminate CO_2 and H_2S in the biogas to achieve its purification purpose but also provide enough carbon source for algae growth to increase its yield. Preliminary results are very promising. Further work in this direction is in progress.

Methane generated from anaerobic digestion of hog wastes can be utilized as fuel for stoves, gas lamps, ammonia-water absorption refrigeration system, vehicles, water pumps, grass mowers and generation of electricity, etc.

Selected references: McCarty, P. L.: Public works for Sep. 1964; Hong C. M., M. T. Koh, T. Y. Chow, P. H. Tsai and King-Thom Chung; The seminar on Agribusiness Systems for Integrated Crop-Livestock-Fish Farming, Philippines, 1979.