Note

Deodorizing of Sludge Solids
by Actinomycetes[†]Ayaaki ISHIZAKI,
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Malaysia, a member of Association of Southeast Asian Nations, is becoming industrializes and therefore faces pollution like other developed countries. The Malaysian government passed the Environmental Quality Act 1974, which has been enforced in its entirety since 1981 after the addition of schedule for intermediate stages of enforcement. According to the Act, the Biological Oxygen Demand limit for industrial waste water discharged into rivers of the group described as "Standard B" (not upstream of water supply intakes for human drinking) shall not exceed 50 ppm. Methods of the waste water treatment using activated sludge can meet this BOD limit except for the problem of the inactivation of sludge. Without proper treatment, the dumping of excess sludge can give rise to unpleasant odors and unsanitary conditions.

Much chicken dung is used by vegetable farmers in this country and we thought that excess sludge might be recycled as organic fertilizer as part of an integrated system for the treatment of waste water for food industries in Malaysia. Deodorization is the key technology for this process. Various microorganisms have been used for deodorization,^{1~6)} the actinomycetes are effective, especially for solid organic wastes such as pig feces and poultry droppings.^{7~12)} We studied the use of these organisms to remove the unpleasant smell from the drying process of excess sludge from the activated sludge water treatment system of Malaysian food industry.

Thirteen strains of Actinomycetes were isolated from soil in and around the factory premises of Ajinomoto

Malaysia. Agar plates consisting of activated sludge extract (60% by vol.), nystatin (30 mg/liter), cycloheximide (30 mg/liter) and agar-agar (20 g/liter) were sterilized at 120°C for 30 min. The preparation of the activated sludge extract is shown in Fig. 1.

One gram of soil was suspended in 10 ml of sterile water and shaken for 10 min. The soil suspension was spread on the surface of an agar plate, which was then incubated for 48 hr at 50°C for monoclonal isolation. The 13 strains isolated were used for the monoculture experiment to evaluate their deodorizing potential. Inocula of individual strains were prepared by the culturing of a loopful of a slant stock culture in a tryptone-yeast extract broth 24 hr in a shaking flask (170 rpm) at 50°C. Inocula were transferred to a modified sludge medium (MSM) that consisted of powdered activated sludge (15% moisture; 18 g), sawdust of a Malaysian timber mill (2 g), 1 mM L-alanine (2 ml),¹³⁾ 10 mM Na₂HPO₄ (2 ml). The moisture of the mixture was adjusted to 55% with 40 ml of distilled water to start the growth of the actinomycetes. The moisturized mixture was

FIG. 1. Treatment of the Activated Sludge Extract for Medium Preparation.

FIG. 2. Apparatus for Blowing Air over the Surface.

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FIG. 3. Microbial Population, Unpleasant Smell and pH during Culture.

—●—, actinomycetes; —○—, bacteria; —○—, fungus; —△—, smell; —□—, pH.

sterilized in an autoclave at 120°C for 15 min. Four grams of incubated MSM (20% w/w on a dry basis) were then transferred to 16 g of sundried sludge (approximately 15% moisture) to make the unsterilized sludge preparation for the deodorization test. Ten percent sawdust was mixed with unsterilized powdered sludge and the initial moisture was adjusted to 55% with distilled water. These preparation and the control (without inoculum) were kept at 50°C for 4 days with air blowing over the surface of the medium (Fig. 2). During incubation, the odor of the sample was evaluated by panelists selected from the laboratory staff.

Microorganisms were enumerated on nutrient agar (pH 7.4) for bacteria, nutrient extract agar acidified with lactic acid to pH 3.5 for fungi, and sludge extract agar with nystatin (30 mg/liter) and cycloheximide (30 mg/liter) for actinomycetes.

Only two strains (Nos. 13 and 20) were deodorizing. Their data are shown in Fig. 3 with profiles of microbial growth. The data suggest that living cells of bacteria and fungi became fewer while actinomycetes increased during the incubation.

We did gas chromatography model 163 (Hitachi) with Unisole 400 5% and Uniport S 60/80 for the glass column 163 (i.d. $3\phi \times 2\text{m}$) operating at 155°C with a flow rate of nitrogen as the carrier gas of 30 ml/min to identify the volatile fatty acids emitted during the drying of the sludge. Samples for gas chromatography were prepared as shown in Fig. 4. The results are shown in Fig. 5, and acetic acid, propionic acid, *n*-butyric acid, isobutyric acid, and iso-

FIG. 4. Sample Preparation for Gas Chromatography.

valeic acid were isolated. The peaks of these compounds after gas chromatography were absent in a sludge sample treated with strain No. 20. The same was found with the strain of actinomycetes described as HIR 50 provided by Professor S. Hayashida of the University of Kyushu.

FIG. 5. Gas Chromatogram of Volatile Fatty Acids.

Volatile fatty acids of a low molecular weight were the main chemical component of the unpleasant smell.

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