L I T E R A T U R E   R E V I E W

CHAPTER - II

LITERATURE REVIEW

High rate oxidation pond has been studied in New Zealand (Hicks 1958). Taiwan (Soong 1961), at Ahmedabad, India (Ganapati et al 1965) and in Australia (McGarry 1967).

A high rate pond research programme has also been recently initiated at Bangkok in Thailand at the Asian Institute of Technology (Mc-Garry and Tangkasame 1971). In the last place, research has been done at laboratory and pilot plant scales. Twenty four experi--mental ponds were constructed for the treatment of diluted settled night soil. Twentyseven pond conditions were studied with combinati--ons of the levels of variables such as loading, depth and detention period. The ponds were mixed daily by brooms at 9.a.m. and 7.p.m.

Efficient waste water treatment and high yields of algae are achieved through the operation of a high rate pond at 200 lbs. BOD/acre/day loading,17.7" depth and one day detention time. Under these conditions, effluent BOD/algae removed is lower than 10 mg/1 and one acre of pond can produce about 100,000 lb or 45,400 kg.of algae dry weight per year. At solar energy levels of 480 gms-calories per sq.cm.per day, 2800 lb/day (1270 kg/day) of dried algae (with less than 10% moisture can be produced on one acre).

An urban model has been suggested that incorporates recycling of reclaimed clarified pond effluent (after treating with alum or alum plus poly electrolytes) for household cleaning purposes. Potable drinking water would be supplied through a separate distribution system. Use of such a dual distribution system would effect a two third reduction of conventional water supply requirements.

"Research on the system under tropical conditions is now required in the fields of animal nutrition, product processing, market analysis, and process economics, both at the pilot plant and photo type scales (Mc Garry and Tangkasame 1971).

Ganpati et al (1965) have described the type of high rate aerobic lagoons which were in use in the Pirana Sewage Farm at Ahmedabad, India. In the extensive farm of 2850 acres on the eastern bank of the river Sabarmati, broad irrigation was carried out on 2500 acres and the remaining 350 acres at the farthest end of the farm were converted into 280 plots of "solar drying beds.", where raw settled sewage, not required for irrigation was stored to a depth of 2 to 27 inches and allowed to pereolate and to evaporate in the sandy soil on the bank of the river. The algal solids were removed finally from each bed and sold as manure.

Impounding raw settled sewage (which had travelled over a distance of six miles in narrow open channels with a self cleaning velocity) was practised as a distinct treatment method since 1932. Two distinct processes were taking place in the ponds:(a) Synthesis of profuse green and blue green algal organisms making use of the fertilizing element of sewage, and (b) concomitant release of large quantities of dissolved oxygen. The 282 ponds were examined for their physico-chemical and microbiological conditions during the different seasons of 1961-62 and the results have been published already.

The so called "solar drying beds" of Ahmedabad resembled in important repsects the high rate aerobic ponds in their smaller area and depth with detention periods of less than one week, where stabilization of sewage was brought about solely by the photophy--sidogical action of green and blue green algal organimms (Ganapati et al 1965). Bhaskaran and Chakrabarti (1966) tried to purify cane sugar waste first by an aerobic digestion followed by "an aerobic oxidation pond 4 ft-(1-2 m) dwp at an average BOD loading of 300 lb/acre/day. The over all BOD removal was 70%.

Again Golucke (1960) states "An extensive knowledge of the ecology of the organisms involved in the process for the treatment of waste in a high rate exidation pond is required. This is true because effective biological control required an optimum relationship between the environment and the biotic community concerned and this can be accomplished only by providing proper environmental factors to which an algal-bacterial community is subject in an oxidation pond.".

"There is paucity of information in the literature on the effect of these environmental factors either individually or collectively on such organisms when living as members of a biotic community. His statement holds good even to day and justifies this thesis.

Also, it has been observed that waste treatment plants which base their entire operation on microorganisms within them, have been designed for the past fifty years or so with almost no consideration for the biochemical reactions brought about by the various microorganisms (Mckinney 1962). Parker (1962) has also stated that no detailed study of the dominant bacterial species occuring in different types of oxidation ponds has been made so far. Studies of bacteria involved in the normal functioning of waste treatment processes are relatively few in number." Although reports which list the specific organisms involved in aerobic oxidation in stabilization ponds are not available, it is extremely likely that the aerobic bacteria of ponds, which are mainly con--tained in a yellow brown flocculent sludge (The substance created bio-flocculation) differ but little from those found in activated sludge or in trickling filter slimes(22)" (Oswald 1960).

In the same paper (Oswald 1960, p 384), he has stated that in the case of the high-rate aerobic ponds," A healthy sludge comparable to activated sludge is maintained in the pond, providing mixing is carried out for about three hours a day. Following an initial accumulation, the volume of aerobic sludge does not increase, but rather remains constant indicating essentially that total oxidation is taking place."

It is not known whether a specific microflora is responsi--ble for complete oxidation of organic matter in this case or whether the phenomenon is associated with any other biochemical process. The advocates propounding the theory of total oxidation of organic matter by bacteria have not advanced biochemical proofs of their contention.

It will require therefore, renewed investigation of a more exhaustive nature to establish definitely that in some cases alone like the activated sludge and trickling filter processes bacteria partly oxidize organic matter and in other cases (high-rate oxidation pond) completely oxidize the organic matter.

The algae are valuable as a direct source of food for Zoo-plankton and fish and also as an agent helping to maintain the fertility of aquatic soil. Thus they are very important as abio--geo-chemical agent and as a transformer of energy and therefore must be harbested for useful purposes. They also require careful studies in high-rate aerobic ponds.

Again the specialised treatment structures imposed by the mechanical aspects of the three different systems of treatment, have been arrived at by purely emperical procedures and are perhaps responsible for causing differences in the patterns of microbial degradation of organic matter. This is indicated by the strikingly different periods of time taken for purification in each case. In the case of the activated sludge process where huge quantities of the flocs are in constant turbulent motion sweeping through the liquid to be purified, the contact period between the organic wastes and the activated sludge when stabilisation is brought about is 4-6 hours. The contact period between the wastes passing through a trickling filter and microbial surfaces on filter stones is approximately thirty seconds, according to the studies made at the Robert A. Taft Engineering center and at the Purdue University (Mckinney and Pffefer 1965) in the case of the oxidation pond neither of the above phenomenon occurs. The time required for organic wastes to be purified by algal-bacterial symbiosis is ordinarily 20-30 days in this comparatively sluggish conventional process which is lessened to 2-6 days in the high-rate oxidation pond (McGauhey 1960). The structural features of the three treat--ment systems would therefore seem to determine largely what species accomplish treatment (Lackey and smith 1956). The types of bacteria concerned in algal-bacterial symbiosis and the pattern or pathways of degradation of the soluble organic substrates are still unknown (Golueke et al 1954) although enormous literature has been published on certain other aspects of the low cost waste treatment systems.

These facts may be considered sufficiently convincing to justify a detailed biochemical study of algal-bacterial symbiosis in high-rate aerobic pond systems with varying detention periods and algae.

In this thesis the following aspects such as (a) the degree of purification attained; (b) algal biomass production (c)photosyn-thetic oxygen production (d) CO_2 requirement for algal biomass production (e) input-output energy balance; (f)CO_2 production from bio-oxidation of sewage organic matter; (g) O_2 requirement for bio oxidation ~~of sewage organic matter; (g)~~ etc, have been studied using the algae Chlorella vulgaris, Euglena gracilis, Microcystis aeruginosa and Baroda Sewage.

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