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ENERGY FROM URBAN AND INDUSTRIAL WASTES

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A diversity of wastes the human societies produce on earth, *viz.*, liquids, slurries and solids, when considered superfluous by that society become waste.The quantities of the various waste streams depend on a variety of factors, such as cultural patterns, prosperity, technological development, climate, region etc.The quantity of wastes produced in a society particularly depends on its prosperity, and in general it can be stated that the more prosperous the societies are, the more wastes are set free in society. Consequently, the more potential resources are lost. Due to this non-sustainable life-style, and despite all the publicly advocated concern of politicians about the quality of the environment and the needs and interests of coming generations, these societies are faced with enormous amounts of surplus materials.

Waste to Energy Option

Human activity all over the world generates large amounts of waste material. These wastes have serious environmental and ecological consequences and are also potentially harmful to public health. The fact that our surroundings have a limited capacity to absorb these wastes is being realized all over the world. Earnest efforts are on to handle wastes in an efficient and scientific way. While attempts are being made to minimize the generation of wastes and to reuse and recycle them, the energy recovery option is also being pursued as a viable option. Thus, any integrated waste management system which aims at beneficial use of wastes should have the waste to energy option built into it, in order to maximize environmental protection and economic viability. In this context urban and industrial wastes assume significance with their proven potential as sources of energy generation.

The decision of the Government of India in this decade to expose out industries to global competition has compelled many major industries to look into the areas of efficient processes, energy and water conservation, conformation to environmental legislation with regard to waste disposal, air pollution control measures and solid waste disposal.

Conventional Approach for Sewage Disposal

Conventional domestic sewage treatment approach aggravates the problems in the wastewater treatment. Day by day new chemicals are being synthesized and produced commercially. Some of the problems faced in wastewater treatment are: (i) development of suitable micro-organisms to treat many obnoxious synthetic chemicals pertaining to particular industries and related nutrient requirements for the special microbes, (ii) the problem of high total dissolved solids in the wastewater which inhibits bacterial growth and (iii) colour removal in certain types of waste water.

Large quantities of urban, municipal and industrial wastes are generated every day in our country. The studies conducted by the Central Pollution Control Board, New Delhi and Operations Research Group, Vadodara in a few Class-1 cities indicated that the per capita generation of municipal solid waste (MSW) in urban areas is about 0.4kg. per day with a collection efficiency of about 60% and liquid waste of 150 litres per day with a collection efficiency of about 60% and liquid waste of 150 litres per capita per day. Total waste availability for class-I cities has thus been estimated at about 27 million ones of MSW and about 4400 million cubic metre of sewage per annum. In addition, large quantities of wastes are also generated by several industries, such as, sugar mills, distilleries, pulp & paper mills, dairies, slaughterhouses, tanneries, pharmaceutical industries, etc., Unscientific methods of collection and disposal of these wastes have led to increase in pollution an environmental degradation, posing considerable hazard to public health and local as well as global environments.

Recent Developments in Waste Treatment and Disposal

In recent years, several waste-to-energy technologies have been developed and demonstrated, which not only help in reducing the quantity of waste but also generate substantial quantities of energy. Besides recovery of large quantity of energy, these technologies help in reducing the quality of waste and also improving its quantity for meeting the pollution control norms. A potential of generating about 1000 MW of power from urban and municipal wastes and about 700 MW from industrial wastes has been conservatively estimated over a decade ago, which is likely to increase with further economic development.

In our country, where access to safe drinking water is not yet guaranteed to the considerable fractions of the population, it is of great importance to maintain the hygienic quality of surface waters as high as possible: it is likely that all the quantity of surface water will, at least for some time, be used as drinking water. Therefore, it is necessary to eliminate as completely as possible the microorganisms present in sewage that may cause the proliferation of water-borne diseases. Most biological treatment systems are inadequate for the removal of these so-called pathogenic micro-organisms and an extra treatment step in specific unit is normally needed to effect pathogen removable and thus obtain an effluent with an adequate hygienic quality. Different methods, including chemical (disinfections), physic-chemical (ultraviolet irradiation) and physical (sand filtration) have been used. In tropical countries the use of lagoons is an attractive alternative. The effluent of a treatment plant is discharged into shallow ponds, where it remains for a sufficiently long period to obtain significant pathogen removal by natural die-off. The rate in these lagoons, also called maturation ponds, may be accelerated by using the available sunlight to create adverse environmental conditions for the organisms, such as high temperature, a high pH (by photosynthetic carbon dioxide consumption) and direct sunlight radiation.

Once the minimum effluent quality has been specified (particularly the maximum admissible concentrations of solids, organics, nutrients and pathogens which can settle out), the objective of the treatment is to attain reliable the set standards. The role of the design engineer is to develop a process that will guarantee the technical feasibility of the treatment process, taking into consideration other factors such as construction and maintenance costs, the availability of construction materials and equipment, as well as specialized labour.

Primary treatment alone will not produce an effluent with an acceptable residual organic material concentration. Almost invariably biological methods will be used in the treatment system to effect secondary treatment, i.e., the removal of organic material. In biological treatment systems the organic material is metabolized by bacteria. Depending upon the required final effluent quality, tertiary treatment methods and / or pathogen removal may also be included.

In practice, the overwhelming majority of waste – water treatment plants use aerobic metabolism for the removal of organic material. The most familiar aerobic processes are the activated sludge process, the oxidation ditch, the trickling filter and aerated lagoons. Stabilization ponds use both the aerobic and the anaerobic mechanisms. In recent years there has been a growing interest in anaerobic treatment of wastewaters, including sewage. Several demonstration and full-scale systems, notably of the 'Up flow Anaerobic Sludge Blanket' (UASB) process, have been operated successfully in regions with tropical and subtropical climates and to a lesser extent, in moderate climate.

The Anaerobic Process

During the past decade anaerobic process technology has come to be recognize as a commercially viable treatment technology to deal with high, medium and low strength wastewater incorporating different types of advance reactor systems in place of conventional reactors. The advancement in the understanding of anaerobic microbiology and the engineering to retain the biomass inside the reactors has replaced the normal drawbacks of conventional anaerobic system and thus have resulted in the evolution of high rate anaerobic system e.g. Upflow Anaerobic Sludge Blanket (UASB), Anaerobic Fixed Film Reactor (Upflow& Down flow), Expanded / Fluidized Bed Reactor, Hybrid Reactor System etc. bearing different trade names for commercial application.

The Anaerobic Process for Energy Production

Conventionally, both aerobic as well as anaerobic methods have been employed for biological degradation of complex organic carbon in industrial effluents. However, anaerobic digestion of organic carbon present in these effluents produces a combustible gas, methane, thus allowing waste treatment to be coupled with bioenergy production. This singular feature has made anaerobic system e.g.Upflow Anaerobic Sludge Blanket (UASB), Anaerobic Fixed Film Reactor (Upflow& Downflow), Expanded / Fluidized Bed Reactor, Hybrid Reactor System etc. bearing different trade names for commercial application.

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In the aerobic process, the organic carbon present in the effluent is used up the mixed aerobic microbial consortium as its carbon and energy source. The complex organics finally get converted to microbial biomass (sludge) and carbon-dioxide.

In the anaerobic process, the complex organics are first broken down to a mixture of volatile fatty acids (VFAs), mostly acetic, propionic and butyric acids. This is achieved by "acidogens", a consortium of hydrolytic and methane by acetogenic (acetogens) and methanogenic (methanogens) bacteria respectively.

Thus, while both aerobic as well as anaerobic degradation routes can equally remove complex organic from the effluents, the anaerobic route has an obvious advantage in that it produces methane, a combustible gas with a reasonably good calorific value (24 MJ/m^3). The production of methane, a renewable energy source, is alone a strong ecological reason for employing anaerobic treatment or "Biomethanation" and preferring it wherever applicable.

Biomethanation requires adequate infrastructure facilities. The first and the foremost among them is the bioreactor in which the treatment is to be carried out. Extremely large volumes of effluents are encountered for treatment. Thus, an optimally designed bioreactor can decrease the treatment time and increase the treatment efficiency, leading to an overall lowering of the treatment cost.

Selection and design of bioreactors are dictated by process kinetics. In biomethanation, kinetics of the acidification reaction (acidogenesis) as well as the methane formation reaction (methanogenesis) are taken into account. Since the average growth rate of the methanogens is much lower than of acidogens, the overall rate of the biomethanation process is therefore controlled by the methanogenic step. It is seen that the rate of biomethanation can be accelerated only by enhancement of the rate of conversion of VFAs to methane.

Conclusion

For the successful implementation of waste management there should be gainful co-ordination among all stake holders including municipal departments, private enterprises, recycling trade and industry, waste collectors, NGOs and resident welfare associations for undertaking the collection, transport and disposal of urban solid waste. At the municipal level, and in the industries a separate department should be responsible for waste management. The hospital wastes should be handled as per the stipulated rules of medical waste management. Appreciating that the existing infrastructure may be appropriate, it is stressed that appropriate funds be provided to enable the provision of facilities, and necessary levels of services, in solid waste management.

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