Waste Management in Cities of India Needs Introduction of Modular Concept for Sustainable Solutions

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Abstract

Waste Management in major cities in India is generallya grey area that needs proper attention. The rapid growth in population in cities caused due to mass influx of rural population in search of employment and better living and also the fast changing living standard in various strata of society are some of the major factors which are rendering even a properly planned scheme to a stage of inadequacy in a very short span of time. A scheme on waste management by the time it is physically implemented on ground is found to become under capacity, facing deficiencies all over places.

Whether it is solid waste management or Waste Water Management, the issue of under design and need of augmentation is a common problem being faced on the ground. In such situations of rapid expanding dimensions of problems, introduction of Modular Concept in design of schemes can be more effective and convenient in design, implementation, and subsequent augmentations in phases.

Solid waste management which is basically on the principle of 6 R i.e., Recycle, Reduce, Reuse, Repair, Re-gift, and Recover, can be planned and designed on a modular basis for a population of 5000 to 10,000 and earmarking a zone of 100,000 sq. ft. as "Solid Waste Area" having various facilities for composting, incineration, plastic shredding facility, metal segregation cells, cell for electronic waste, and everything at a place to function in an organized manner. Such operations can be handled by RWAs collectively with necessary aids from municipal authorities and the government. Such modular units of waste handling can serve as a tool for local employment.

The "Modular Concept" similarly can also be well applied to Waste Water Management for handling liquid waste from colonies of population of 5000 to 10,000. There are various methodologies for waste water treatments and waste water recycling depending on the nature of the waste, but out of the lot, use of RBC (Rotating Bio Contactors) is more appropriate for small/medium capacity which can be conveniently subjected to phase wise augmentation by adding additional modules time to time.

The present concept for aggregating the waste and handling it to transport the entire waste, be it the solid waste or the liquid waste to a far corner of city area for purpose of centralised handling/treatment and disposal. This concept of centralised handling of large mass needs a re-look in the present scenario.

Keywords : Modular concept, sustainable solutions, waste management

I. INTRODUCTION

With advancement in lifestyle in society, rapid introduction of plastic articles, rapid growth of electronic gadgets in day to day living, increase in use of battery and dry cells, increased use of synthetic items, there has been a basic transformation in nature of solid waste being received from households. It is no more only the kitchen waste.

Again with emphasis on organic farming, increase in demand of organic vegetables/fruits, the value of organic waste from households has gone up, well highlighting the need of composting of organic waste. With the introduction of incineration techniques, a bulk of mass from collected "Solid Waste" can be straight converted to ash by use of incinerators in a safe way. Oil fired incinerators or electrical incinerators can be a viable answer to this volume reduction issue. Plastic waste can be tackled by the process of shredding, the other two constituents of domestic/industrial solid waste are the

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segregation of metal parts and segregation of electronic parts and battery/cells of different kinds. Such items need initial processing before recycling/re-use and require a technical approach for handling.

In a similar way, the "Modular Concept" can be useful in management of liquid waste also which can be the domestic sewage or industrial waste. Separate modules need to be established for domestic sewage and industrial/commercial liquids waste as their treatment process may be different based on nature of the waste. Modern sewage treatment plants normally involve four basic processes :

(i) Collection

(ii) Pumping

(iii) Preliminary Treatment

(iv) Wastewater Treatment

Waste water treatment may further involve processes like physical and chemical treatment techniques where removal of contaminants like oils, dissolved solids, and metals may be needed. The composition of liquid waste depends mainly on its source. The three main common sources are (i) Residential, (ii) Commercial, and (iii) Industrial areas. Storm water is also a source of liquid waste at certain places. Therefore, treatment plans need customized design based on the nature of liquid waste.

Apart from the conventional method of Mechanical treatment comprising of steps like Bar screen chamber,Clarifier, Aerators/Activated sludge chamber, Chlorination and waste water recycling, many packaged technologies are now in practice which can be well applied for smaller modules suitable for population of 5,000 to 10,000.

↳ Membrane Bio Reactor (MBR) Technology : This concept was introduced in 1960s but thereafter, it was gradually refined in stages. A refined design given by manufacturers like Zenon Environmental (Canada) and Kubota(Japan) in 1990s with introduction of flat sheet technology[1].

↳ Moving Bed Bio film Reactor (MBBR) Technology : The first MBBR was installed in 2006 in NORWAY[2].

↳ Rotating Bio Contactor (RBC) Technology : The first RBC plant was installed in West Germany in 1959.

↳ Thermal Hydrolysis Technology is a process in which sewage and sludge are subjected to high temperature and pressure particularly suitable for industrial waste.

↳ Solar Photocatalytic Technology is a process where light energy is used to drive certain chemical reactions. TiO2 is used as a photo catalyst.

↳ Microbial Fuel Cells (MFC) Technology : It is a new Bio Electro Chemical process which aims to produce electricity from MFCS.

↳ Natural Technology for Waste Water Treatment (WWT) with help of ponds, lakes water bodies : Waste water gets naturally treated.

Waste water is likely to become a major resource for production of Hydrogen which has the potential to become a fuel for automotives and engines in the coming future. Thus, the process of management of waste water is going to be prime focus in future.

II. SOLID WASTE MANAGEMENT – A TYPICAL MODULE

Every zone of population of around 5000 to 10,000 may be provided with local "Solid Waste" handling unit which should be managed by the associations of RWAs with adequate aid and technical assistance from government and municipal authorities. Such modules should essentially comprise of provisions like composting chambers adequate in numbers, a plastic shredding unit with facility of packaging and loading, unloading, a

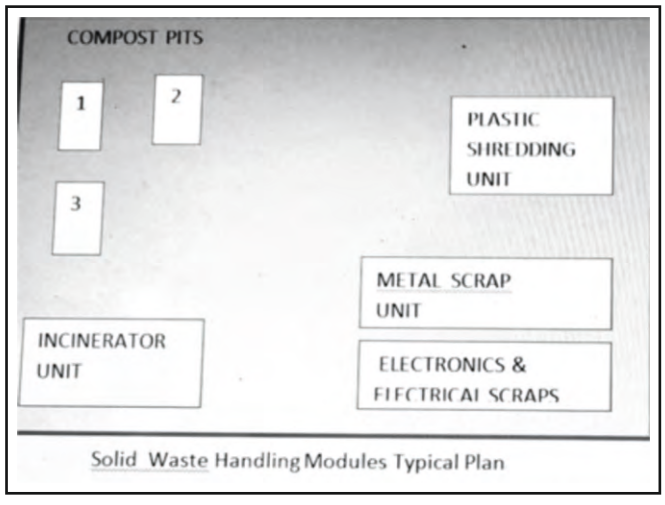

Fig. 1. Solid Waste Management Typical Plan

separate unit to handle metals scraps such as iron, aluminum, tin, zinc etc., and another chamber to handle electronics waste, batteries/cells.

Organic waste handling is the most crucial part of overall functioning and its disposal after composting needs close monitoring. Proper handling can prevent organic waste from turning into a nuisance. This becomes an economic entity for use in organic farming. Waste in the form of cotton waste, clothing, paper/cartoons need bulk reduction by process of incineration for which electrical incinerators, as well as oil fired thermal incinerators are available in market to suite the size and required capacity. The plastic shredding unit handles plastic waste by shredding it into minute pieces and packaging the mass for transportation to plastic manufacturers and recycling centres.

The Metal Scrap Unit and Electrical and Electronics Scrap Unit play their role separately under proper coordination of constituted technical management body.

However, still more important is setting up a mechanism to integrate all the functional modules/units of the entire city area for lateral coordination, monitoring, and supervision. Such action needs to be taken by Municipal Authority/Nagar Nigam. The resources generated in the form of compost bags, shredded plastic packages, metal scrap, electronic and electrical scraps must be disposed off / marketed in a coordinated manner. Thus, each of solid waste management modules shall be functioning as a productive unit and remain under the overall control of municipal authorities/ 'Nagar Nigam'.

The future expansions of the system becomes easy and convenient with surge in civic population on a time to time basis. This simply means addition of a standard module in the system to cope up with the increased load.

III. MODULAR CONCEPT OF PLANNING FOR WASTE WATER MANAGEMENT

Liquid waste/waste water management is another problem area faced by cities of India mainly because of rapid increase in civic population. Running systems are being rendered under-capacity resulting in overflowing of sewers/drains, choking of manholes, overflow of sewage in manholes making entire surroundings of habitable area unhygienic. By the time a new system gets completed, it becomes under capacity/obsolete. Answer to this problem is again in adopting a "Modular System". There is no point in collecting sewage from each nook and corner of the city and transporting the whole mass through huge drains to still larger conduits and finally, to an extreme end point of city area for Centralised Treatment/Processing of the whole mass in large Sewage Treatment Plants and finally, discharging the effluent water in water bodies.

Thus, the present concept is to collect small masses, integrate them to form a large mass and then transport the large mass to a distant place and then treat it en-mass to achieve economy of scale. This method and design may succeed in situations where parameters are static and stable, but in the present Indian condition where cities are witnessing rapid expansion in population and requirements are increasing day by day, this method is bound to succumb to tremendous load. Thus, the solution lies in modular approach.

The first step in this direction is to design a *Waste Water Management Module* for a zone of 5,000 to 10,000 population. Each module is to have adequate scope for future expansion. There are plenty of technologies available to manage waste water depending on the nature of sewage, its constituents like domestic waste, industrial waste, chemical waste, presence of oil, grease etc. Among the various technologies, the RBC technology is found more suitable for predominantly domestic sewage. The reason is the lesser requirement of space, compactness in layout, an odourless and nuisance free operation free from noise and sounds of machines. Such plants are available in small and medium capacity units to be installed in small places like parks or even in closer vicinity of domestic accommodations. The system needs least maintenance. Rotating Biological Contactor is an efficient fixed-film wastewater technology for secondary and/or advanced biological treatment. This can be a viable choice for modular treatment plants in city zones.

IV. A TYPICAL MODULE FOR WASTE WATER MANAGEMENT – RBC TECHNOLOGY

As mentioned in Section III, Rotating Biological Contactor or RBC is used for secondary treatment of wastewater. The process takes place in three segments:

(a) Primary Treatment

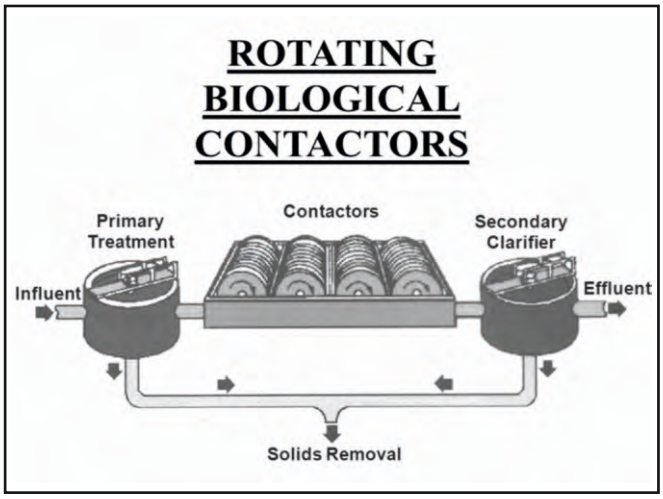

Fig. 2. Rotating Biological Contrcators

(b) Secondary Treatment

(c) Final Treatment of effluent

The primary treatment process involves removal of grit, sand, and coarse suspended material through a bar screen followed by settling of suspended solids during specified retention time. Thereafter, secondary treatment starts in RBC plant.

The RBC process allows wastewater to come in contact with a biological film in order to remove pollutants from the wastewater before discharge of the treated wastewater to the environment, usually a body of water (river, lake or ocean). A rotating biological contactor is a type of secondary (biological) treatment process. It consists of a series of closely spaced, parallel discs mounted on a rotating shaft which is supported just above the surface of the wastewater. 40% of the disc remains submerged in sewage water. The disc continues to rotate slowly with 1.5 to 2 rotations per minute. Microorganisms grow on the surface of the discs where biological degradation of the wastewater pollutants takes place.

Rotating biological contactors (RBCs) are capable of withstanding surges in organic load. To be successful, micro-organisms need both oxygen to live and food to grow. Oxygen is obtained from the atmosphere as the disks rotate. As the micro-organisms grow, they build up on the media until they are sloughed off due to the shear forces provided by the rotating discs in the sewage. Effluent from the RBC is then passed through a clarifier where the sloughed biological solids in suspension settle as sludge. The waste water gets diverted to recycling network where it is utilised for arboriculture , gardening, and other purposes except for direct human consumption.

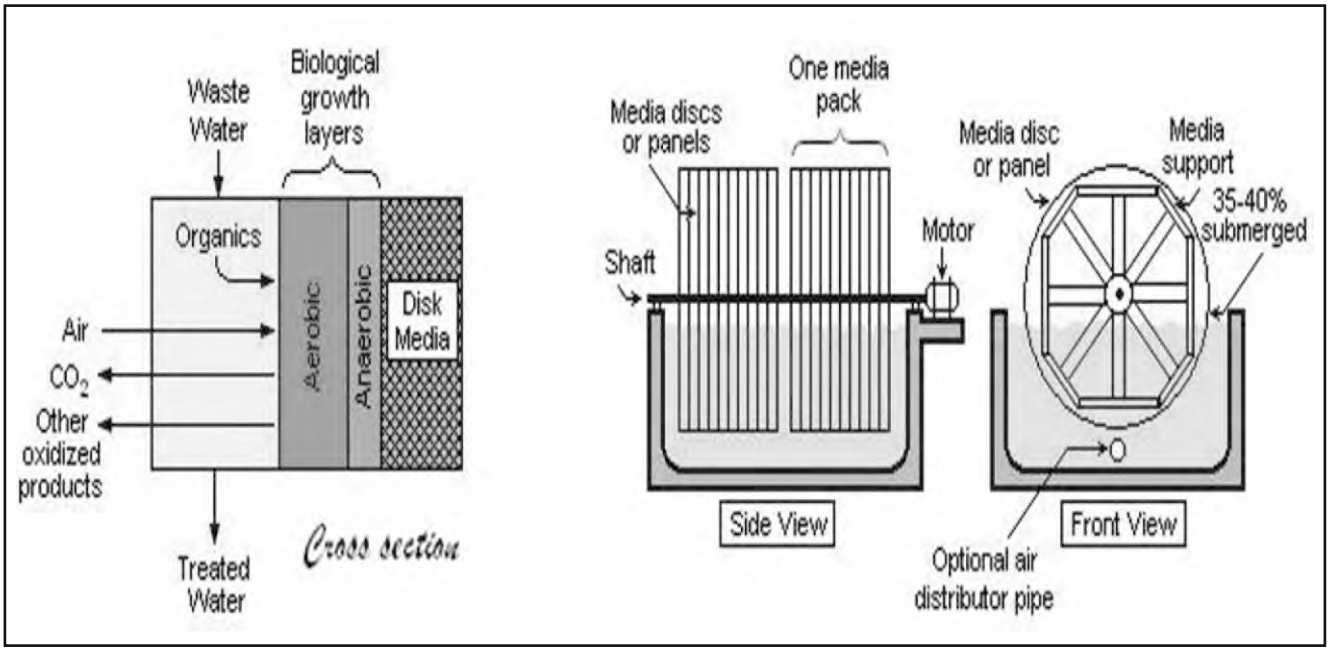

Fig. 3. Structure of Rotating Bio-film Contactor

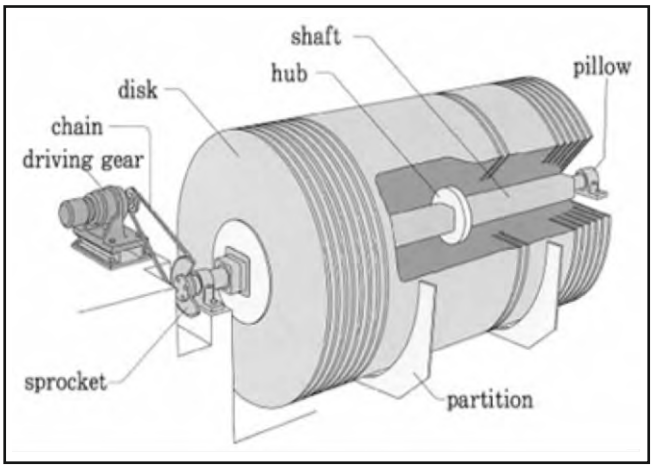

Fig. 4. View of Rotating Bio Contactor

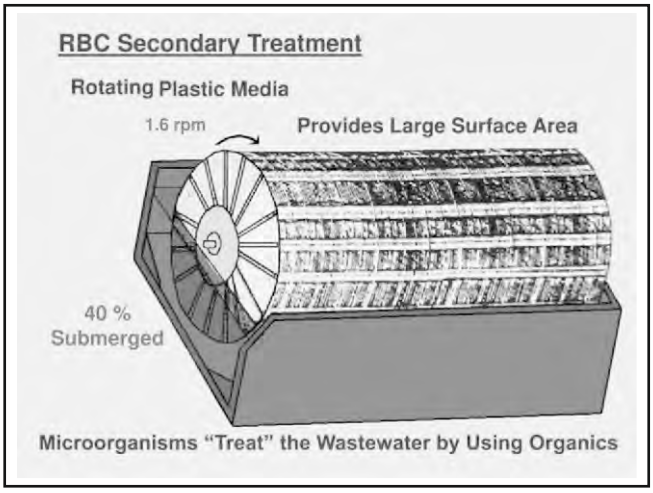

Fig. 5. RBC – Disc View

Advantages of RBC

- Consistent process results
- Stable operation without frequent supervision
- Lower expansion and retrofit costs due to modular construction
- Short waste water hydraulic retention time
- Minimal head loss through system
- Low energy consumption
- The only maintenance required is simple drive and bearing lubrication
- Reduced life cycle costs as compared to suspended growth systems
- Simple in operation since no sludge recycle
- Operator friendly
- Easy for upgradation and multiple application

V. PREVAILING SCENARIO IN MAJOR CITIES

Metropolitan cities and large capital cities which are already having central sewage treatment plants in place may adopt the modular concept of small /medium plants, particularly for suburbs and newer colonies being added.

Private developers engaged in housing construction may be insisted upon to establish modular system to establish a sort of uniformity in waste management system. The overloaded segments of existing system may be relieved by putting a few selected colonies on a modular system.

In major cities and capital cities of states, the modular concept may be introduced by dividing the city in zones and installing solid waste management and liquid waste management modules in a phased and coordinated manner.

VI. CONCLUSION

A co-ordinated plan is required to be made for recycling of effluent water after having required treatment of effluent produced from RBC Plant. The water because of reduced BOD and COD is generally suitable for arboriculture and gardening purpose. It can be used for sprinkling on roads and road sides for dust control.

With the fuel scenario changing fast and Hydrogen likely to become the main fuel for transport and automobiles, recycled waste water is likely to become the main resource for Hydrogen production on a commercial scale. Thus, the waste water management modules have a bright future in times to come.

AUTHOR'S CONTRIBUTION

Mahesh Prasad is the sole author of this paper and he has done the entire work for the paper. There is no co-author for this article.

CONFLICT OF INTEREST

The author certifies that he has no affiliation with any firm/organization and there is no financial or non-

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About the Author

Mahesh Prasad, B.E. Civil Engineering (1972), M.E. Civil Engineering (1993), M.B.A. (1997),started his career as Assistant Professor (Civil Engineering) in 1972 with Department of Technical Education (Bihar). He got associated with erstwhile Central Water and Power Commission, Flood Forecasting Division at Patna (1975). This was the time when Patna witnessed a historical flood due to peak flows in river Sone and river Ganga. He worked to develop an empirical formula to forecast water levels in the river Burhi Gandak, Bihar based on the rainfall data in catchment area of this river which proved to be quite effective. Thereafter, he served in Military Engineer Service, Ministry of Defence from 1976 to 2010, and retired from the post of Chief Engineer in 2010. Thereafter, he remained associated with an Australian MNC firm, SMEC International as Senior Consultant, where he got associated with prestigious projects like AIIMS at Rishikesh, ESIC Hospital at Lucknow, and tourism infra-projects in Sikkim (2016). He was empanelled as National Quality Monitor (NQM) with Mininstry of Rural Development, NRRDA,PMGSY from 2017 to 2020.