Review Article

New Strategic Route for Total Depolluting Cities with Emphasis on Sewage and Allied Solid Wastes' Productive Management

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Abstract

Invisible and visible pollutions have been problems, which cause varieties of human discomforts, health hazards and deleterious effects on vegetation, environment and ecosystem. It is both natural and anthropogenic problem. In any production and consumption system, right from alimentation of bio-systems within and outside of bodies up to industrial manufacturing, there occur some wasteful products. The waste decomposition becomes a store house and site for detritus food chain for consumers such as bacteria, virus, insects, flies, etc., to multiply and create environment nuisances. These wasteful products require suitable treatment, disposal and reuse, if possible. Local governing bodies have taken responsibility to clear waste including sewage sludge and all solid wastes emanating from different sources. Efforts have been made to install conventional piped sewerages, clean the streets and dump the wastes in the earth-fill sites. In some cities, new processing plants have been installed for converting solid wastes into electricity generation; however their success and sustainability are to be established. The piped systems become defunct due to restriction of flows caused by variety of reasons and over flow, which requires severe and frequent maintenances. It needs to develop some strategic route and management technologies to eliminate these essential services' problems, which concentrate in cities due to large agglomeration of habitations. This article presents a new route, design and installation of piped systems, their operations and maintenance of setups, which will be regularly cleaned, solid wastes processed to produce least cost involving manure for agriculture and wastewater used for enhancing biodiversity. This total depolluting management technology can be organized to function under the public-scientific-partnership (PSP), which becomes inter-dependent revolving enterprise in depolluting cities and creating varieties of employments.

Keywords: Environment, Pollution, Sewage, Sanitation, Waste decomposition.

Introduction

With advancement in quality of living, the concern is steadily increasing in maintaining sanitation, right from personal hygiene to environmental pollution. While personal hygiene is self-driven, the environmental depolluting activities are taken as governments' responsibility. The usual slogans promulgated from time to time provoke the need and importance of depolluting environment.

The slogans are:

"Cleanliness is Next to the Godliness".
"Clean and Green" slogan is common in cities.
"National Sanitation Mission" is launched in India.

In order to understand domain of sanitation, process-based analyses should be carried out. In any production process, there occur some good

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(main) and bad products (as side effects), right from alimentary canal of bio-organism (including human) up to the industrial products. The bad products include waste products and toxic gases, which create pollution problems. These waste products need suitable treatment, disposal and reuse to the extent possible.

There exists variety of inconsiderate and considerate disposal of the wastes. The wastes' inconsiderate disposals of kitchen wastes, house cleaning, sweeping of streets and dumping at site for further sorting and waste treatments, itself provides ample detritus food chain. In developed colonies and organized housing societies, the wastes are collected and disposed of by enforced manpower. But, in any case the site of dumping is not free from the vagaries of development of detritus food chain. The excretal wastes are problems from open defecation to dry latrines and the piped disposal systems. Piped disposal system is not free from problems of high cost of installations, repairs, maintenance and overflows due to variety of causes. Thus, there remain problems of sewage disposal in spite of several provisions. Several estimates and provoked statistics indicate that almost 45% (may be subject to correction) of habitants do not have access to toilet facilities. Some NGOs have attempted to eliminate problems of night soil carriage from the earlier system of dry latrine, by introducing system of toilets. However, in this situation the problem of excretal waste disposal gets deferred and the domain becomes still more severe; requires careful consideration for devising suitable reformative measures to deal with severe problem of basic and compulsory need of living. The animal dung is used for various purposes, which may not apparently appear a problem, but when it comes to the decomposition it creates scenic disorder and methane emission, which is an important greenhouse gas (GHG). Treatment and management of these wastes is important. This article deals with innovative technologies for total depolluting cities.

S. No.	Sub-systems	Product	Quality of pollution	Existing treatment measures	Problems that need solution
1	Garbage	Trash including kitchen wastes	Unscenic, cause problem when decompose in water and environment interactions	Remove and burning different types of garbage	Creates environmental problems and toxic fumes, emits hydrogen sulfide, affect brain of the children that generate encephalitis, etc.
2	Dung	Lifted and used for manures and making cooking fuel	Produces methane and creates further unaesthetic scene	Remove and use for anaerobic decomposition foe production of methane	Lifting from the site and transportation to site of treatment involves high cost. The sustainability of the plant working is difficult.
3	Sewage	Sewage sludge and waste water	In aesthetic scene, toxic liquid and sludge, toxic gas, and pathogenic bacteria.	Deep buried sewers, expensive manholes and junction boxes, sewage treatment up to at most secondary stage enabled to remove carbon.	N and P containing waste water disposal pollutes rivers, etc., leading to eutrophication and harboring mosquitoes causing different disorders.
4	Sludge and rain water	Largely combined for sewage and rain water piped channels	Water polluted by sewerage, polythene, trashes, dung, etc.	Some screens to filter grits, etc., sewage water treated up to secondary treatments.	All available water is polluted water.

Table 1.Status of Sanitation Sub-systems

Sanitation System Components

The sanitation involves three components of depolluting strategy, viz., removal of trash and sweepings including kitchen wastes which are termed as garbage. The second component includes dung, etc., which emanates from animals. The third component of sanitation is the excretory wastes emanating from toilets which are called sewage. These three components are to be treated separately. Their process, quality characters and existing treatment routes and resulting situation need to be looked into so as to enable to find some novel route to cut across the inherent problems.

The garbage, dung and sewage and waste water cause problems and need some innovative technologies. The treatment technologies for the three components of sanitation are dealt with in this article.

Innovative Technology

The component-wise innovation brought in the technologies is as under:

Garbage

Garbage is voluminous; hence its collection and handling is voluminous, costly and time consuming. Therefore, size reduction is a very important aspect. The large volume should be reduced that will enable easy handling of garbage eliminate problems of different dimensions. The garbage's' indiscriminate decompositions need to understand the process and chemical reactions v in the sulfur cycle [1, 4].

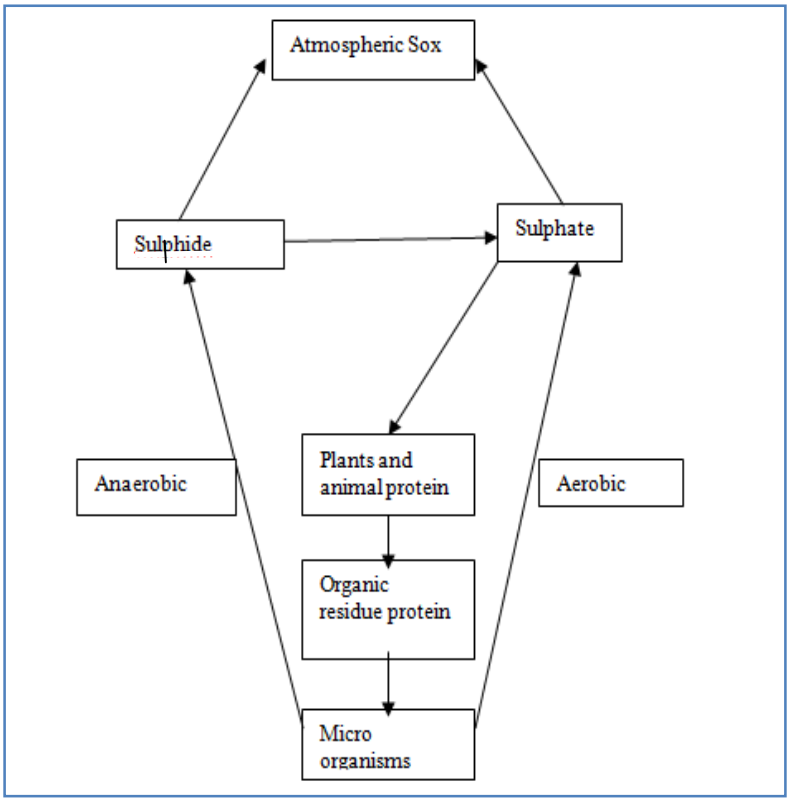

Figure 1.Sulphur Cycle [1]

The residue decomposition as depicted in the sulfur cycle (Fig. 1) follows two different routes: aerobic and anaerobic. The aerobic decomposition produces sulfate, which is directly absorbed by plants to promote growth and yields. Contrary to this, anaerobic decomposition produces hydrogen sulfide, which is highly dissolvable in water. The water containing hydrogen sulfide causes deterioration of plumbing-both supply and sanitary/ waste plumbing. At high concentration, it chokes throat and becomes killer gas in wells. Yadav et al. 2008 reported detailed overview of hydrogen sulfide and fatality in open wells in the region. At low concentration in atmosphere it may possibly affect young minds of children and cause mental

fever, leading to encephalitis, as in Gorakhpur region, Uttar Pradesh. This is a simple way to eradicate this type of situation that adds hydrogen sulfides in environment by creating aerobic decomposition of cellulose, in general. This can be acquired by eliminating problem of water logging and providing good drainage to cities. Several studies have established that the aerobic decomposition of garbage (NADEPEP composting) can be easily carried out and problems of greater dimensions eliminated. Therefore, NADEP composting is known to be suitable for producing nutrient of good quality for agriculture. It is a new introduction in maintaining sanitation and depolluting cities.

Earlier piles of garbage in surroundings of cities do exemplify and become evidence of the wrong practice in the past, which added only pollution in the city environments.

Dung

Dung from animals is largely used for making compost, directly applying to fields, deep digestion anaerobically to produce methane, which can be utilized as fuel. This type of application is known since long, but its implication in sanitation is new in introduction. These gas producing and slurry complications reduce attraction of use of dung in methane production. Nevertheless, the nutrient characteristic of dung or the slurry derived from the dung digesters, including slurry derived from the waste water streams become desirable and essential material in preparation of NADEP composting. People's participatory actions will create a successful and remunerative enterprise. Hence, identification of suitable sites for decomposing garbage, cow dung, etc., will form new route for solid waste management in the cities.

Piped Disposal

The applications of piped system in modern cities and townships are known and familiar developments for the present. However, frequent defunct conditions and blockages make the locally affected areas to return to the same worst situation of no existence of sanitary facilities. It requires severe and frequent maintenance leading to heavy burden on the government considering its organization, installation, operation and maintenance, etc. The high cost of deep placements of sewers and associated appurtenances, make the pipe system installation restricted to budget allocation. Many times, there have been deaths of sewer cleaning persons, a bad precedence in recent past, which creates undue burden to settle the issues.

A new system of pipes of same design are installed which is quite suitable for the flat terrain of the city with low gradients. In this system, pipes are laid on the same locations as the conventional existing sewerage system in cities. In this system, each sewer link is provided with a deep chamber such aqua privy or septic tank. Septic tanks in the individual links arrest the solid sewage and induce deep anaerobic decomposition of solid wastes. Deep septic tanks are mandatory in many countries to reduce load of solid waste before the sewage is disposed of in the municipal sewerage system (Lauren, 2006). The main link gets filtered water which can be flown at high velocity with no problem of blockages. The septic tanks are frequently cleaned for which mechanical gadgets do exist in cities.

The innovation in this study is that a new design of septic tank in this research, which, involves low construction and brings refinements in digestion and filtering ability of conventional septic tanks. Another innovative advancement over the aforesaid Zambian sewerage system is extracting the solid waste from the septic tanks and treating it for preparation of the new green manure brand named as Di Ammonium sulfo-Phosphate (DASP) in perspective. This researcher is ready with blue print of development for using the extracted solid slurry. Some details of the nutrient are dealt with in the following subsection.

Nutrient Harvesting

The sewage slurry extracted from the septic tanks installed in every link before it discharges waste water to the main sewer in the system is creating wealth and eliminating several problems. The slurry contains partial unstabilized carbon, nitrogen and phosphorus more than that contained in slurry extracted from the conventional sewerage treatment plants.

This nutrient-rich slurry extracted from the septic tanks may contain heavy metals, as well. The heavy metal involving sewage sludge did cause devastating damage to land and environment. The affected farmers stopped using waste water

for irrigation with sewage sludge for irrigation. In this situation, sewage sickness is resulting problem induced by hydrogen sulfides. This particular situation needs careful treatment to reduce bioavailability of heavy metals and eradication of the development of hydrogen sulfides. This sewage slurry is converting into activated charcoal to be used as booster dose for application in agriculture. Reviews (De, 2010; Davis and Cornwell, 1997) show the immense potential of bio-inactivation and application of booster dose of manure in agriculture. This aspect requires more research investigation for undertaking exhaustive application of new technology.

This aspect of development of earlier known Zambian sewerage makes further more attractive and lucrative. Reduction in the cost of deep placement of sewers and appurtenance, severe repairs and maintenances, blockages and risk to the workers of the existing sewerage systems of municipal corporations are the emanating benefits from this new system of shallow layout of sewers.

Wastewater Use for Enhancing Biodiversity and Ecoreserve

The wastewater treatment does not require special treatment in this new route of sanitation. Rather, this sewage filtered water rich in N and P and loaded with heavy metals can be directly utilized to produce biodiversity needed for the cities. Use of bio-charcoal will act as adsorbent of toxic salts and absorbent of gases and help contain carbon sequestration for enhancing ground water recharge. Creation of suitable raised bed and furrow and activated charcoal will filter. Growing reed is universally accepted species to use the waste water, produce canes which are used as alternative to timber, thus, help conserve forest biodiversity.

Design Details

The innovations brought out in the preceding section are suitably designed to cope with site demands. The innovations are devised to acquire status of universal applications. Supporting components may need some specific design.

S. No.	Subsystem	Component	Remark
1	NADEP compost	NADEP chamber	Many chambers can be created as it depends on the availability of garbage, dung, slurry etc.
		Placement of garbage and green biomass, dung or the waste water stream slurry can be put in three 15 cm thick layers	Some research may be required to accelerate aerobic decomposition. The decomposition does not release any bad smell/disorder. Hence, it does not create any detritus food chain.
		Open auction of NADEP compost	Some technological innovation may come to reduce requirement of NADEP compost chambers.
2	Dung	Methane for energy	This component may be organized in semi-urban, perurban areas. The net benefit will come to the city depolluting status.
3	Sewers	Pipe sewers	Figure displays the arrangement.
4	Appurtenances	Manholes and junctions	Figure displays the setup.
5		Septic tank	Figure displays the arrangement.
6		Main sewer line	The sectional view depicts the lay out.
7	Open drain	Rain water	The rain water free from sewage, etc., should be released in lakes, ponds, rivers, etc., that will save water free of any pollution.
8	Nutrient derived	Production of biochar	New renewable material made to eliminate long-time known and existing problem of water quality.
9	Wastewater	Wastewater used	This eliminates cost of wastewater treatment by municipalities. No disposal in the rivers, lakes, ponds, etc., as green rain water.

Table 2.Design Details of Different Subsystems of Detoxification of Cities

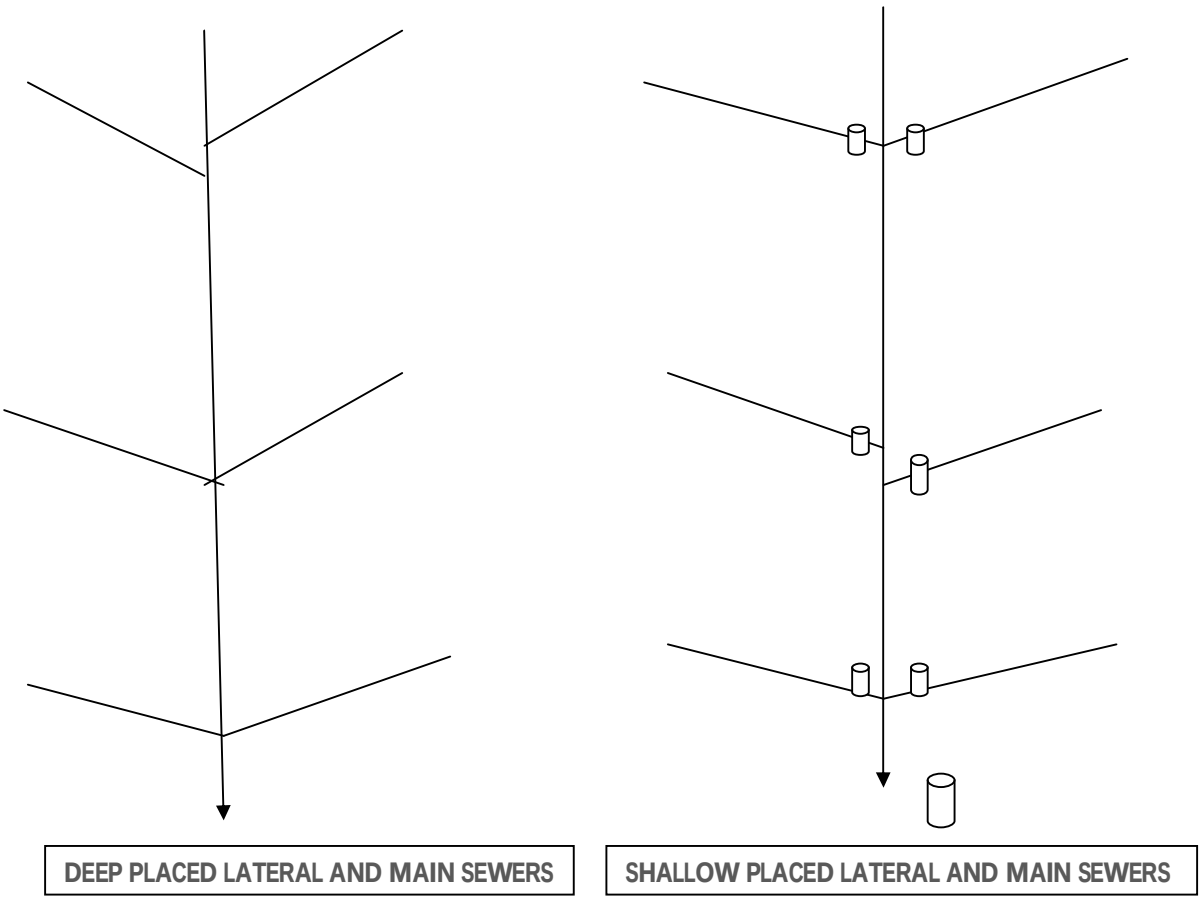

Figure 2.Planform of Installation of Deep and Shallow Depth Sewers

The design of NADEP chamber standardized as per convenience of handling of filling and removing the compost. An NADEP chamber in a week or so can be filled. Thus, a number of NADEP chambers need to be constructed at suitable sites in different zones. The nutrient content of the aerobically decomposed compost is better than that of conventional compost prepared in pits.

Designs of the deep digester generating cow dung gas plant or digestion city plants have also standard known designs. It is common in use. Only problem remains of removal of CO_2 and water vapor from methane. This author has obtained a patent of his research on eradication of polluting gas, the technology can be utilized for removing CO_2 and vapor and enhance burning efficiency of methane.

The shallow laid sewers are designed as open channels that have been customary for sewer design. The non-silting velocity of flow is 1 m/s but should not be less than 0.6m/s. The sewer size is decided by taking 4× design discharge. This consideration brings 1.25 times safety factor. The basic change is that there should be separate conveyance for sewerage and for handling of runoff water. This has become necessary to cope with aberration in flow due to climate change and elimination of pollution of water.

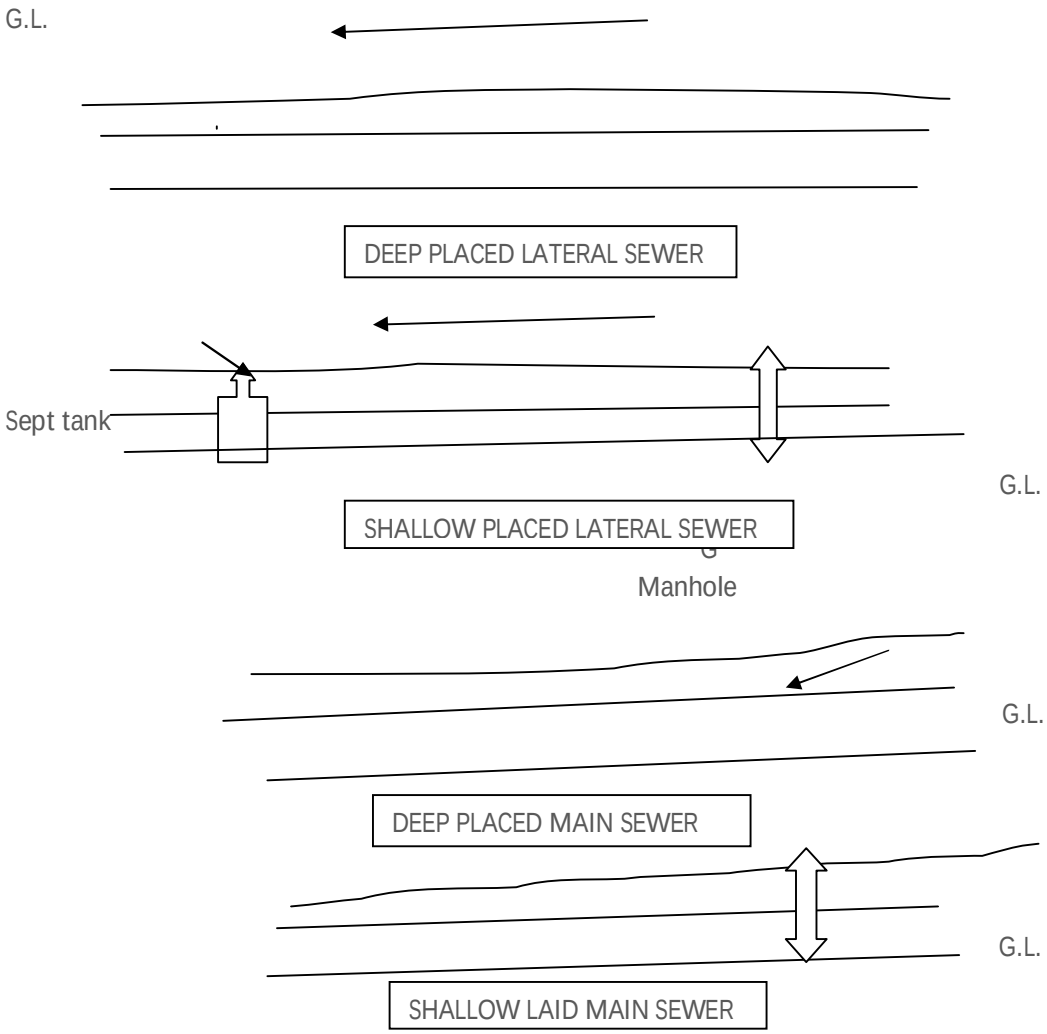

Figure 3.Placement Details of Deep and Shallow Lateral Sewers

The shallow imbedding and installation of septic tank in lateral lines to filter solid waste and allow only filtered water to flow at nominal low gradients is a simple and low-cost technology. This technology will be savior for covering non-sewerage part of cities and new cities.

The gradients are as under:

Diameter (mm)	Minimum gradient (m/ km)
225	11
300	8
375	6
450	4.5
600	3
750	2.25
900	1.75
1050	1.5
1200	1.25

Table 3.Minimum Sewer Gradient

The pipe sizes may suitably be increased to handle discharge and laid at shallow depths. Thus, this type of sewer layout enables reduction in the cost.

The Septic Tank

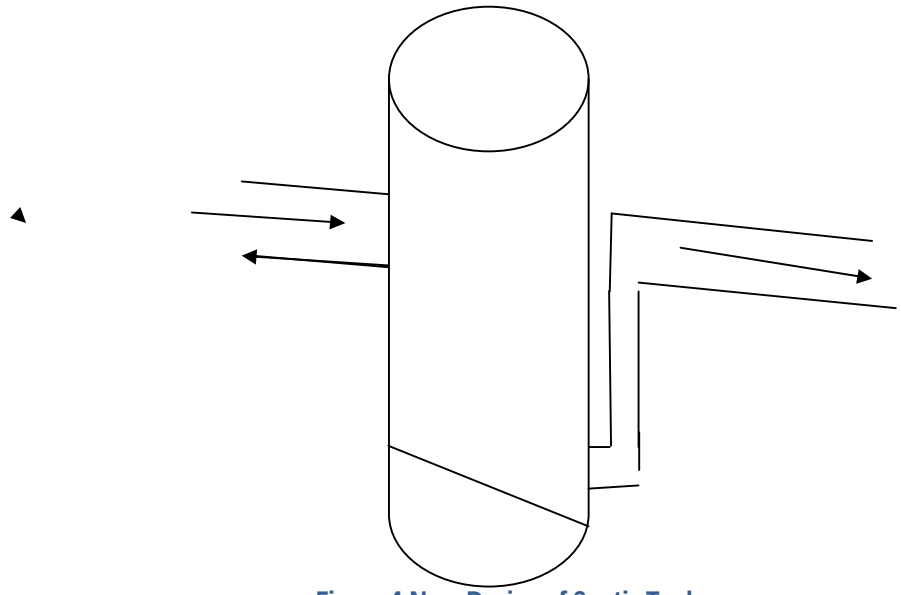

Figure 4.New Design of Septic Tank

Use of Recovered Sewage Sludge Solid

The deposited solid sludge is extracted from the septic tanks and dried to produce biochar. The biochar is useable in agriculture fields as amendment to make it act as booster and bio inactivation of toxic salts and heavy metals. This is a new innovation and makes world free from sewage pollution. It eliminates worry of secondary and tertiary treatment of sewage sludge, which acts as new route of solid waste management from problem-causing to benefit-producing.

Prospects of the Technology

It is clear that a new route for maintaining total sanitation is created which will eliminate all limitations of sanitation carried out by other methods. The new route for eradicating bad situation is capable of removing the lack of sanitation. The new route removes the pollution-causing situation and converts it into beneficial products. There is provision for separate drains for sewage, i.e., sewers and drainage ditches separately. The design criterion is same as the conventional system of maintaining sewer system. Thus, the alternative route is sure to function and eliminate problem of blockages, frequent failures, and getting defunct, need of maintenance cost, savior for sanitation and inducing participation of user of nutrient recovery and waste products of sewage sludge. It is a resource-creating technology and makes several confirm decisions to detoxicate cities.

The real innovative technology is installation of shallow-depth sewers, which eliminates high cost of installation and appurtenances. The budget so saved can be utilized for extending the sewer facility to the other part of the city.

Frequent repair is eliminated by creating a vested interest of keeping the piped system functional for all times. Thus, the operation and maintenance responsibility is shifted to another organization that eliminates burden of sanitation on the municipal bodies.

The sewage sludge waste and waste water are used to produce several other benefits, whereas lot of budget is drained in treating the sewage sludge. Conversion of sewage sludge into biochar is entirely different route that will produce unimaginable benefits.

Thus, the sewage a nuisance due to poor management will produce huge wealth. This technology alleviates the problems and creates new assets for deriving wealth from the waste. The change in modality of function needs orientation of the people involved in this activity. This technology is pro-scientific facts hence a public scientific partnership (PSP) program needs

to be launched to undertake the projects of sanitation.

Such pilot projects will serve as extension agency and will create resource for extension of adoption by the municipal corporation. The execution and benefits interest is shifted from the municipal set up to the profit-making group, which will work for their existence that will bring welfare of the people. The ultimate goal is achieved without much expense to the government. This project will create employment at several levels.

Conclusion

The study presented a new route of sanitation which converts bad scenario to entirely beneficial new enterprise to bring several benefits. This new technology will enable cover the remaining portion of gentry having no facility of toilets.

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