

# CONSTRUCTION OF MOBILE TOILET USING BIO TOILET SYSTEM

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## ABSTRACT

The disposal of human waste is very big problem in high altitude areas. In non-glacier region the waste is collected and used as a fertilizer in the field. Bio digester toilet is defined by the decomposition of human waste. Incineration and chemical treatment of human waste also has been attempted to overcome problem. However, all this method are unhygienic or not practically viable alternatives. Biological treatment is an attractive approach for solving the problems, but decreased metabolic activities of the micro-organisms.

## 1. INTRODUCTION

The disposal of human waste is very big problem in high altitude areas. In non-glacier region the waste is collected and used as a fertilizer in the field. Bio digester toilet is defined by the decomposition of human waste. Bio toilet is the innovative technology for disposal of solid human waste in an ecofriendly, economical and hygienic manner Bio toilet is a complete waste management solution which reduces solid human waste to bio gas and pure water. Is colorless, odorless and devoid of any solid particles. Requires no further treatment/waste management. Can be used by for irrigation purposes. Incineration and chemical treatment of human waste also has been attempted to overcome problem. However, all this method are unhygienic or not practically viable alternatives. Biological treatment is an attractive approach for solving the problems, but decreased metabolic activities of the micro-organisms. Using anaerobic bacteria for the digestion process reduces the volume solid waste. Bacteria they themselves increase their amount. Pathogenic bacteria is a common type of bacteria using for methane and bio gas productions. This type of bacteria come under anerobic condition. In the digestion tank the chlorination process is followed by digestion process. By using mobile toilet with bio technology reduces the volume of water using for flushing purpose. Mobile toilet with bio technology is totally differ from normal mobile toilet. It consumes less amount of water.

## 1.1 SALIENT FEATURES

- Suitable for subzero temperature of Himalayan regions
- No dependents on limited on costly conventional energy sources
- Reduce the volume of water
- Easy to transport
- Maintenance free, continuous biological process
- Eliminates the pathogens
- It consists of light indicator system
- Flushing system

## 2. LITERATURE REVIEW

Following literature review is observed for obtaining the base for the completion of this project work carried out by the Research Designs and Standards Organization under the title Specification for "Retention Tank Toilet System with Chemical Treatment" gives the following details Retention tank toilet system with chemical treatment treats human waste so that solids are treated and entrapped in the filter. The liquids are made free from pathogen before being discharged. It is applicable to western and Indian style toilets of main line broad gauge (BG) coaches of Indian Railways. This Schedule of Technical Requirements specifies the waste processing, discharge and interfacing of Western and Indian style toilets to be fitted on different types of main line broad gauge (BG) coaches on Indian Railways. General Requirements: Generally, IR mainline passenger coach has 4 toilets, of either Western commode or Indian squat-pan types. Some coaches may have only 2 or 3 toilets. The number of toilets and their type (Indian or western) depends upon the coach type. Irrespective of coach designs the biological toilet system is required to meet the following objectives: Clean, odor-less, hygienic and aesthetically pleasing toilet. – No discharge

of unprocessed waste. – No spillage of wastes on the bogie parts, under gear or track. – Minimum life cycle cost to IR the toilet system should be simple to operate and safe for users. It should not contain any components, which are prone to pilferage. It should be robust, reliable and low-maintenance, and should require minimum ground facilities at the terminals or enroot stations for its operation. The system should be able to handle normal waste and even some foreign objects thrown in (such as bottles, caps, napkins, plastic bags & cups etc.) either by segregating or by processing the same. Any choking should be possible to be rectified on the spot without needing attention of maintenance depot. The water consumption shall be minimum, with 100% wash of the commode (max. 2.5 liter per flush for Indian type and 1.5 liter for Western type). The toilet system is required to suit the space constraints of different types of coaches. All parts of the system should be at least 225 mm above rail level (preferably 400 mm). The equipment should not impede free -movement of the bogies, nor the routine inspection & maintenance of various bogie/coach subassemblies.

Methodology for Design and Fabrication of Human Waste Disposal System for Indian Railway – A Review (IJSTE/Volume2/Issue07/2004)

The toilet system offered must be of a proven and established design. Documentary evidence along with certificate of performance (clearly specifying the operating conditions and design) of the toilet system supplied during last 5 years, should be provided by the tenderer, along with contact details of the users. The design of the toilet system should be suitable for application on various designs of Indian Railways passenger coaches. The tenderer may however make suitable changes in his original design to adapt the same to IR’s requirements. This shall be done at the tenderer’s sole responsibility and cost.

Documentation: The suppliers must submit documentary proof of the system being of proven design and for the various components and material used in the toilet system. The successful tenderer shall provide detailed drawings and specifications of the components critical to it’s proper functioning. Sufficient numbers of illustrative manuals shall be supplied for installation, commissioning, preventive maintenance and trouble-shooting. Consumables required for the system (including chemicals for cleaning, disinfections as well as waste processing) shall be informed. A list of spares to be kept by the maintenance points shall be informed with their costs. The tenderer shall submit the life-cycle costing for the toilet system offered by him, and include the following cost details: – Landed cost of the toilet system – Annual recurring cost of operation – Annual recurring cost of preventive maintenance – Annual recurring cost of repairs. From this we have learned the process of bio toilet they implemented in railways from this we have get an idea of

construction of mobile toilet by bio technology. It can useful for the village areas where the non-availability of sanitation and it is a easy way of disposal of sludge. In mobile toilet consists of normal toilet interior with flush system which consumes a low volume of water. And several new ideas with cost reduction has implemented in this mobile toilet. The toilet consists of three layers for several process. And it is a movable one. Digestion of human waste is followed by bio technology.

### 3.MOBILE TOILET WITH BIO TECHNOLOGY

#### 3.1 BIO-DIGSTER TOILET

Biological decomposition of human waste.

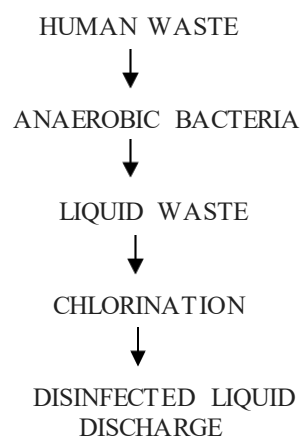
Bio-Toilet is an innovative technology for disposal of solid human waste in an eco-friendly, economical and hygienic manner. A Bio-toilet is a complete waste management solution which reduces solid human waste to biogas and pure water, with the help of a bacterial

#### 3.2 IMPORTANCE OF BIO-TOILET

- Easy digestion of human waste
- Movable one
- Less cleaning processes
- Consume less amount of water
- High life time for the cleaning of septic tank

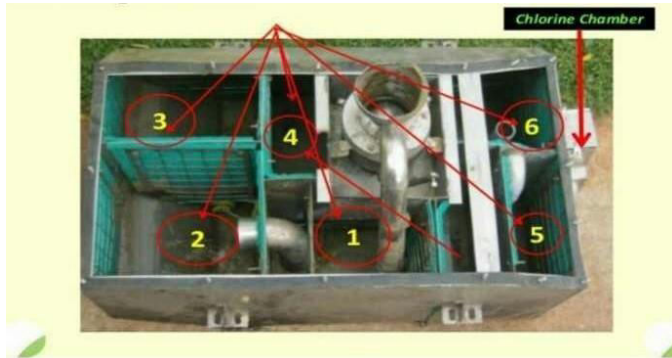
#### 3.3 WORKING OF BIO TOILET

When human excreta come in contact with bacteria, it gets converted into methane and water through a series of anaerobic bacteria digestion hydrolysis, acidogenesis, acetogenesis and methanogenesis. Faecal matter is space composed of carbohydrates, protein and fats. In the first step, they are converted in simple sugar, amino acids and fatty acids. In the next step, this breaks to for carbonic acids, alcohols, hydrogen, water. In third steps acaricide, hydrogen and carbon dioxide are formed. In the last step methane, carbon dioxide and water are formed.



### 3.4 MAIN PARTS OF BIO-TOILET TANK

- Stainless steel tank with 06 partition walls inside the tank.
- Poly grass mats for potation of bacteria inside the wall.
- Ball valve with handle for operation during emergency for operation during emergency for making toilet direct discharge in case of choking.
- SS fasteners in place of MS on tank cover.
- Stronger bonding of colonized rubber mat vertical walls.



### 3.5 ADVANTAGES OF BIO-TOILET

- No bad smell in toilets from the tanks
- No Cockroaches & flies
- Fecal matter in the tank not visible
- Effluent is free from off odor and solid waste
- No maintenance required
- Reduction in harmful organic matter by 90%
- No requirement of adding bacteria
- No need of removal of solid waste

### 3.6 PROCESS OF ANAEROBIC SYSTEM

Many microorganisms affect anaerobic digestion, including acetic acid-forming bacteria (acetogens) and methane-forming archaea (methanogens). These organisms promote a number of chemical processes in converting the biomass to biogas. Gaseous oxygen is excluded from the reactions by physical containment. Anaerobes utilize electron acceptors from sources other than oxygen gas. These acceptors can be the organic material itself or may be supplied by inorganic oxides from within the input material. When the oxygen source in an anaerobic system is derived from the organic material itself, the 'intermediate' end products are primarily alcohols, aldehydes, and organic acids, plus carbon dioxide. In the presence of specialized methanogens, the intermediates are converted to the 'final' end products of methane, carbon dioxide, and trace levels of hydrogen sulfide. In an anaerobic system, the majority of the chemical energy contained within the starting material is released by methanogenic bacteria as methane. Populations of anaerobic microorganisms typically take a significant period of time to establish themselves to be fully

effective. Therefore, common practice is to introduce anaerobic microorganisms from materials with existing populations, a process known as "seeding" the digesters, typically accomplished with the addition of sewage sludge or cattle slurry. The four key stages of anaerobic digestion involve hydrolysis, acidogenesis, acetogenesis and methanogenesis. The overall process can be described by the chemical reaction, where organic material such as glucose is biochemically digested into carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) by the anaerobic microorganisms.  $C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH_4$

## 4.CONSTRUCTION OF MOBILE TOILET

### 4.1 MATERIALS

- Wash Basin
- Mirror
- Hanger
- Toilet basin
- Led light
- Solar panel 20w
- Control unit
- Battery 12v-7A
- DC fan
- Switching unit
- Wire
- Flush tap
- Tap
- Valve ON/OFF
- Pipe line work
- Square tub
- Corner bend
- Elevation plate
- Light indicator system
- GI sheet
- Pipe fittings
- Chlorination tank
- Water tank
- Square tub (1x1)
- Square tub(2x2)
- MS 4 length
- Bio tank
- Aluminum sheet

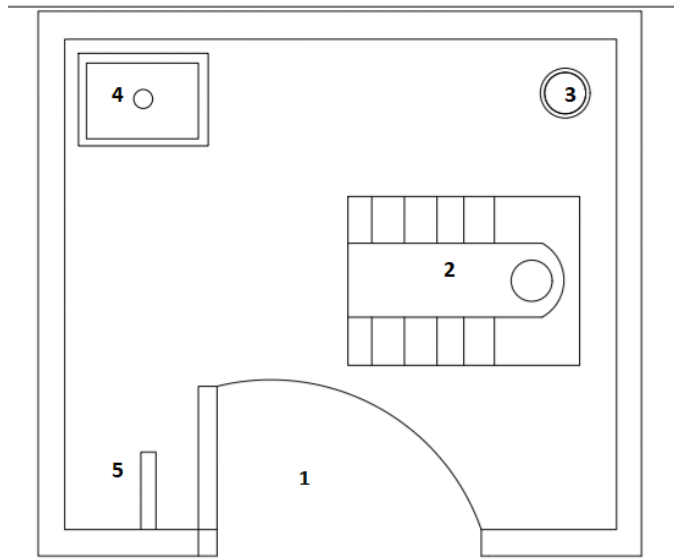
### 4.2 DESIGN OF MOBILE TOILET

Mobile toilet consists of three parts upper, middle and lower parts. Upper part consists of water tank which has a capacity of storage of water 200 liters. The water tank is a plastic tank which is economically low and it can replace if any damages occurs. The water tank is fitted with a pipe for the flow of water into the toilet for the flushing process. And the solar panel with 20W is fitted on the top layer for the purpose of generation of power. The solar panel is environmentally friendly. Middle part is the layer for the toilet which is covered on exterior by mild steel on three sides and with door on another side. The door consists of a light indicator system which indicate as red when someone inside on the toilet and green while toilet is free. And

the toilet is supported with beam and column with steel rods. The interior part consists of steel wash basin for the hand washing purpose, flushing system which consumes low volume of water from 3 to 4 liters at one time flush. And the middle part has dustbin, separate tap, toilet basin. The dustbin is kept at the corner for the dispose of napkin and other waste. The separate tap is provided at the corner near door nearby the place of handling by the person at the toilet. And the toilet basin at a certain size provided at the center of the area. The top and bottom of the middle part of the toilet is covered by the mild steel. The lower part of the toilet has the digestion tank. The digestion tank is fitted in the bottom part of the toilet where the bio technology process is under taken. The bio tank is constructed in the mild steel which is separated has 6 part for the several process of digestion. The chlorination digester is inserted in the digestion tank. The outlet pipe is connected with the digestion tank for the disposal of water after the chlorination process is completed. The top and bottom of the bottom part is covered with mild steel. The three parts are fitted combinedly and it is fitted with the wheels.

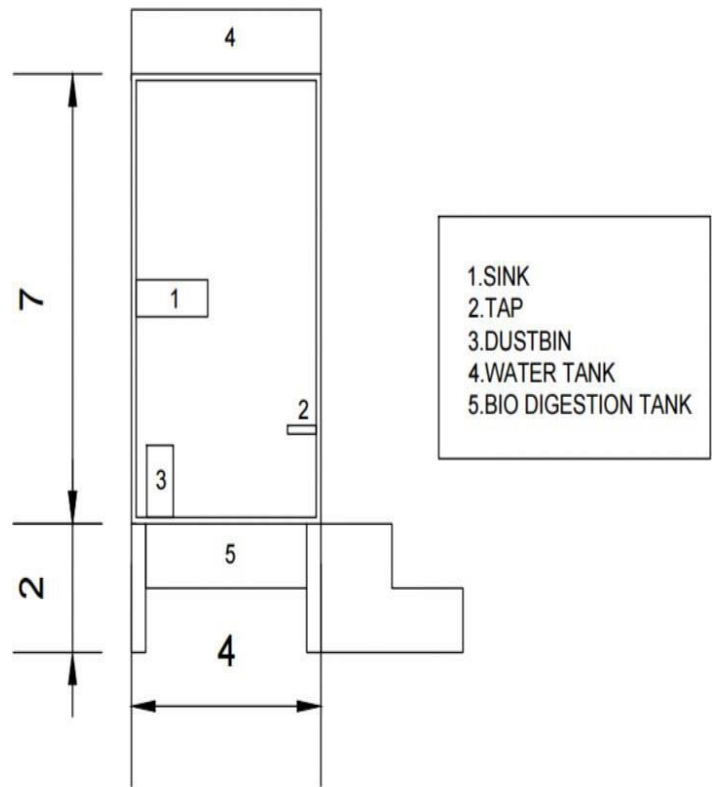
#### 4.3 PLAN AND SECTION

##### PLAN OF MOBILE TOILET



1. DOOR
2. TOILET BASIN
3. DUSTBIN
4. WASH BASIN
5. TAP

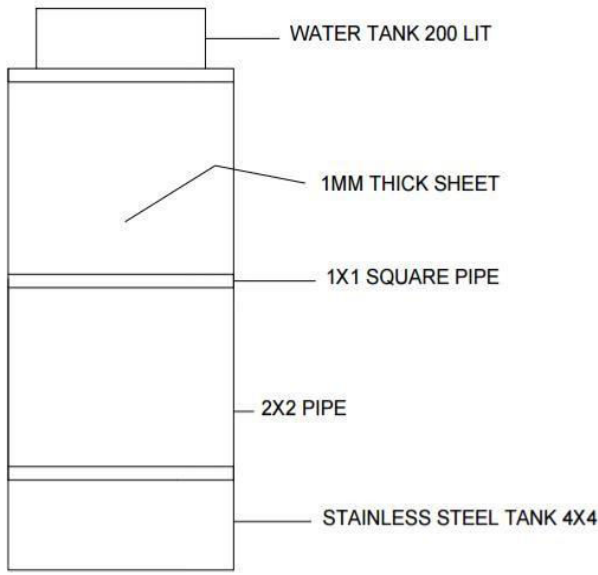
##### SECTION OF MOBILE TOILET



ALL DIMENSIONS ARE IN MM

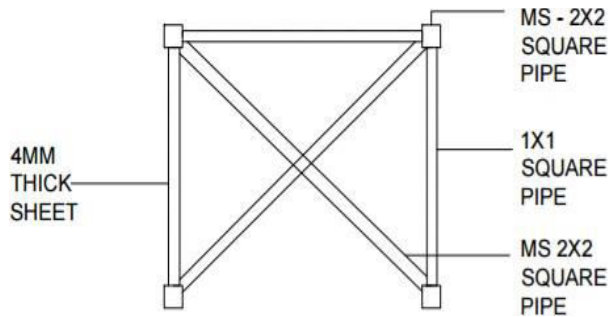
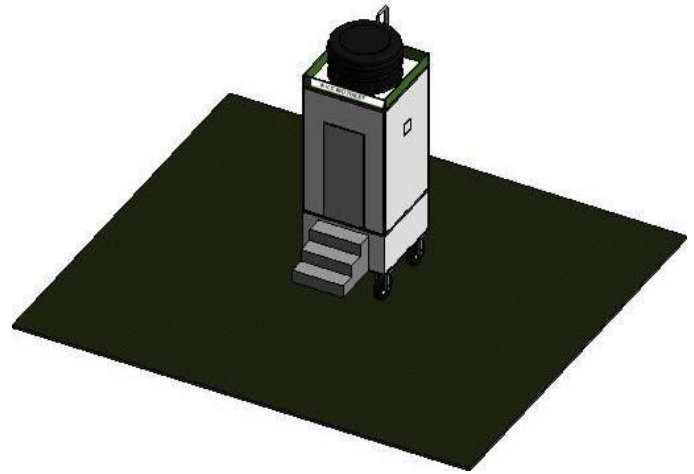
##### 4.4 STRUCTURAL DETAILS

The mild steel covered on the three sides of the toilet is like a bend like formation at the corner end and has the spacing for the providing of columns as square pipe. Square pipe with the size of 2X2 inches which is fitted at the four corners and it is covered with the mild steel with equal spacing on the three sides. The total area of the toilet is 4X4 feet and height is 10 feet. The columns are connected with the three beams on all the three sides. The beams are of square pipe. The size of the beam is 1X1. On the top of the toilet the beams are provided to carry the load from the upper part where the tank is fitted. The loads are equally distributed to all the columns. The columns are provided from the upper to the bottom layer. The wheels are provided on the bottom layer. The mild steel provided on the corners at the thickness of 4 mm. The square tube is the material of mild steel. The three corners are covered with the mild steel sheet with the thickness of 1mm. The door is provided at another corner. The size of the digestion tank is 4X4. The height of the digestion tank is 1 feet. The digestion tank is provided 1 feet above from the ground level.



**SIDE VIEW**

**4.4 REVIT DESIGN**



**BRASSINGS**

**4.5 LOAD CASE DETAILS**

**4.5.1 TYPES OF LOADS**

Types of loads acting on the toilet

- Hydrostatic load
  - Axial load
  - Self-weight of the structure
  - Dead load
- Hydrostatic load is act due to the load from the water tank which has a storage capacity of 200liters. This load changes for full and empty water tank. hydrostatic load act from the upper part of the toilet. Hydrostatic force generally acts in the shape of triangle with maximum force on the top and zero force on the bottom.
  - Axial load is a force administrator acting on the axis. Axial loading occurs when an object is loaded so that the force is normal to the axis that is fixed, as seen in the figure. Taking statics into consideration the force at the wall should be equal to the force that is applied to the part.
  - The dead load includes loads that are relatively constant over time, including the weight of the structure, and immovable fixtures such as walls, plasterboard or carpet. The roof is also a dead load. Dead loads are also known as permanent or static loads.

## **INSTRUCTIONS OF PRESSURISED CLEANING OF BIO TOILETS**

- Visual inspection of complete toilets system including under slung Equipment's.
- Toilet chute to be cleared in bio-toilets if there is chocking.
- Checking the toilets system for any deficiency.
- Charging of chlorine tablets and examination of chlorinator.
- Checking of following equipment's, repair, replacement for proper functioning.
- Flapper/slider/ball valve
- Leakage in piping, flush system, pneumatics, tank etc.
- valves, pressurize, PLC, pneumatic valves, ball valves etc.

- Organization DRDO Bhawan, DHQ PO (2009)
- Journal of Environmental Engineering Editor: Raymond A. Ferrara, Ph.D., M. ASCE, Kleinfelder

## **Guidelines for coaching depots for handling of Bacteria**

- Wear gloves while handling bacterial culture
- Store bacterial culture in containers with lid which can be closed
- During transportation lids should be tightly closed.
- During storage, lids should be kept loose so that the gas generated inside the container can escape easily otherwise container will get damaged physically.
- Do not mix detergents/acids with bacteria at any stage during use.
- Toilets fitted with bio digesters/ bio toilets should preferably be cleaned by pressurized water cleaning system so as to minimize the water usage.
- Clean / sanitize hands with detergents/ soaps after handling of the bacteria.

## **CONCLUSION**

When human excreta come in contact with bacteria, it gets converted into methane and water through a series a step of anaerobic digestion-hydrolysis acidogenesis methanogenesis. Fecal matter is composed of carbohydrate, protein and fats. The bio technology provided in mobile toilet. It secured the environment and make ecofriendly. Mobile toilet using bio technology is useful. The disposal process is easy and the digestion of human waste is totally differed from the normal toilets. Chlorination process clean. The corrosion cost by the fecal matters can be minimized by using bio-toilets.

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