

## ***A Review of Bio Toilet System in Indian Railway***

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### ***Abstract***

*The environment is continuously affected by constant addition of pollution waste material and other hazardous product. It is essential that environment should be protected and maintains to make safe for living. Use of smart toilet or green toilet should help the cause of achieving the goal of environment safety. Indian Railways (IR) is one of the world's largest Rail networks, spreading over 68,400 routes Km. Indian Railways is the lifeline of the country carrying nearly 23 million passengers every day making it the largest passenger carrying system in the world. Direct discharge on track through toilets was creating environmental issue and problem in working to workmen. A Bio-Toilet is a complete waste management solution which reduces solid human waste to Bio-gas and water, with the help of bacterial Inoculums. Biological decomposition of Human waste is done in bio-digester tanks with the help of anaerobic bacteria which is developed at bacteria generation plant. Bio-Toilets are easy to install cost effective and offer environmental friendly solution for sustainable human excreta management. Also, Bio- Toilet is an innovative technology for disposal of solid human waste in an eco-friendly, economical and hygienic manner.*

***Keywords:** Bio-Toilet, Bacterial Inoculums, Bio-digester, Indian Railways.*

### **INTRODUCTION**

Indian Railways (IR) is one of the world's largest Rail networks, spreading over

68,400 route Km. Indian Railways is the lifeline of the country carrying nearly 23 million passengers every day making it the

largest passenger carrying system in the world.

According to the Indian Railway, The first train, Gwalior-Varanasi Bundelkhand Express, fitted with IR-DRDO bio-toilets was introduced in service in January 2011. After receiving encouraging feedback, these Bio-toilets were fitted in more coaches for in-service trials. The pace of fitment of bio toilets has been increased substantially in last 3-4 years. Up to March 2020, more than 2, 42,000 Bio-toilets have been installed in nearly 68,600 coaches including around 47,000 bio toilets fitted in over 14,700 coaches during 2019-20. Ministry of Railways has taken a conscious decision in this regard and has instructed Zonal Railways that no passenger carrying BG coach without Bio-toilets will be put in passenger services from 1 April 2020 and onward.

Further, the Indian Railway has planned to supplement the existing system of Bio-toilet with vacuum flushing system toilet (Bio vacuum toilets), which substantially reduces the requirement of water for flushing, while ensuring effective flushing of fecal matter from the pans. According to Indian Railways, with an aim to provide clean and efficient toilets and to reduce the water consumption in toilets, IR is doing a

trial of Bio-Vacuum toilets. This has aircraft type vacuum toilet on the passenger interface and bio-digester tank is fitted beneath the toilet area on the coach. The faecal matter gets digested in the bio-tanks on board. Up to 2019-20, bio-vacuum toilets have been provided in 729 coaches, including 397 coaches provided in 2019-20. (2)

In order to avoid chocking of bio toilet and to reduce bad odour in passenger area with the reduction of consumption of water used for flushing the toilets, the Indian Railways started installing the vacuum bio-toilets in 2019 after its earlier installed toilets were criticized for being no better than septic tanks. The new bio-vacuum-toilets are based on vacuum evacuation system for Bio-tanks will transfer the fecal matter from the bowl/pan to the bio tank by positive suction and also clean the lavatory bowl/pan with pressurized jet automatically, without affecting functionality of bio digester. The vacuum evacuation is designed in such a way that it sucks out the waste from each toilet with minimum use of water into the Bio-digester tank installed under the carriage. This vacuum evacuation system is isolated from the bio-tank to avoid bad odour in the passenger area, which reduces the bad odour as well as the consumption of water.

They decompose human excretory waste in the digester tank converting it into methane gas, carbon dioxide, and water. The new vacuum toilets have been designed by the Indian Railway along with the Defence Research Development Establishment (DRDE) and Research Design and Standard Organization (RDSO). (2)

The Railway Ministry had said that the Indian Railways Bio-Toilet project is an innovative and indigenous development of technology. According to the ministry, this technology is a first of its kind that has been used by any Rail road in the world for on-board accelerated digestion of human waste. The bio toilet's technology has been innovated, designed and developed jointly by Indian Railways' engineers and Defense Research and Development Organization (DRDO) scientists. The adaption and deployment of the bio toilet technology in large scale has been facilitated by collaboration between RDSO, DRDO and Indian Railways' field units. (3)

## **METHODOLOGY**

In these bio-toilets, the waste retention tanks are fitted below the coach door underneath the lavatories and the human waste discharged/collected into them is

acted upon by a colony of anaerobic bacteria that convert human waste mainly into water, sludge and bio-gas (Methane & Carbon Dioxide). The gases escape into the atmosphere and waste water is discharged after disinfection onto the track. (1)

## **Construction and Installation of Bio Toilet**

These tanks are made of stainless steel and having following constructional features. The size of the tank is 540 X 1150 X 720 MM with the provision of 04 nos mounting brackets at both the sides along the length of the tank. Each bracket is with the provision of 02 nos. M16 Size bolts which are tighten in the under slung on mounting brackets. (3)

## **Main Parts of the Bio Digester Tank**

1. Stainless steel tank with 06 partition walls inside the tank
2. Poly grass mats for protection of bacteria inside the walls.
3. Ball valve with handle for operation during emergency for making toilet direct discharge in case of choking.
4. Stainless steel fasteners in place of mild steel on tank covers.
5. Stronger bonding of Colonized rubber mat with vertical walls.



***Fig.1 Important Dimensions and Volume of Bio-digester Tank***

1. Length – 1150 mm.
2. Width - 720 mm.
3. Height – 540 mm.
4. Total Volume of Tank – 400 lit.
5. Effective Volume of Tank – 300 lit.
6. Empty Tank weight – 110 Kg.
7. Full Tank Weight – 410 Kg.
8. Height from Rail level - 220 mm

decomposition of Human waste is done in bio- digester tanks with the help of anaerobic bacteria which is developed at bacteria generation plant at Motibagh Workshop SECR, Nagpur & DRDE/Gwalior. These anaerobic bacterias convert waste into sludge, CO<sub>2</sub> and methane gas.

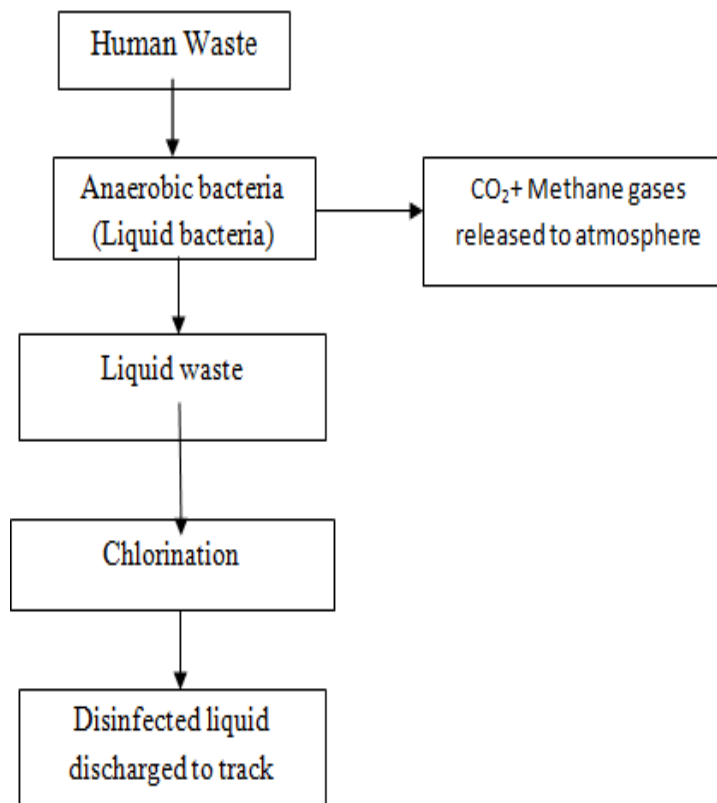
### **Working of Bio-toilet system**

Bio-toilet works on the principle of anaerobic process. The human waste collects in the bio-toilet retention tank. These human wastes go through anaerobic process where anaerobic bacteria with the help of a bacterial Inoculum by bio-degradation process. Biological

After this liquid waste goes through chlorination process and finally liquid and gasses are released to the atmosphere. All the processes have been shown through fig.2.



**Fig.2. Main parts of Bio-digester Tank**



**Fig.3 - Working of Biological toilet System (Anaero)**

**Recommended Parameters**

SN	Parameter (as per APHA Test Method).	Recommended Values	Targeted value(Max.)
1	pH	6 to 9	6 to 9
2	Total Solids	Max 750 mg/100 ml	750 mg/100 ml
3	Total Volatile solids	Max 500 mg/100 ml	500 mg/100 ml
4	Total Dissolved solids	Max 350 mg/100 ml	350 mg/100 ml
5	COD levels	Max 2000 MgO <sub>2</sub> /Lts	Max 2000 MgO <sub>2</sub> /Lts
6	Fecal Coli Forms count	99% Reduction (Less than 10 <sup>8</sup> /100 ml)	99% Reduction (Less than 10 <sup>8</sup> /100 ml)

The parameter has been collected from various sources and available literature. For following lab tests of effluent, lab samples should be collected as per testing scheme circulated by RDSO & results should be recorded in prescribed proformas. (3)

**RESULT AND DISCUSSION**

A Bio-Toilet is a completely biological system. Which convert solid human waste to Bio-gas and water, with the help of a bacterial Inoculums by bio- degradation process? Biological decomposition of Human waste is done in bio- digester tanks with the help of anaerobic bacteria which is developed at bacteria generation plant at Motibagh Workshop (SECR) South East Central Railway, Nagpur & (DRDE)

Defence Research and Development Establishment, Gwalior. To operate the Bio-Digester external energy is not required. In addition to this, there is no need of removal of solid waste as very little amount of sludge generated because of lower biomass produced in the absence of oxygen. The pathogens present in the human waste matter inactivates by anaerobic process. Bio-Toilet is an innovative technology for disposal of solid human waste in an eco-friendly, economical and hygienic manner, which makes it the most acceptable solution for Indian Railway.

Further, the Indian Railway has planned to supplement the existing system of Bio toilet with vaccum flushing system toilet

(Bio vacuum toilets), which substantially reduces the requirement of water for flushing, while ensuring effective flushing of fecal matter from the pans. The main purpose of introduction of this toilet is saving the water. As the tank capacity for waste and fresh water is limited, the most suitable toilet for trains is the vacuum toilet, which only uses about 0.5-1 liter of water per flush.

The common set-up for the onboard toilet system comprises a vacuum toilet module, which has all the required equipment to generate the vacuum, flush and empty the bowl, a holding tank for the waste and supplies for water, compressed air and electrical power.

Through all the above discussion, we are come to the result that the bio toilet is effective and sufficient solution for Indian Railways.

**LIMITATIONS**

It is seen that passenger’s habits of throwing of items like plastic bottles, paper cups, cloth rags, sanitary napkin, nappies, plastic/poly bags, Gutkha pouches on the floor of wagons. However the bio toilet in Indian Railways is facing some drawbacks including degradation of human waste where the end products such as liquid discharges are being thrown in open areas and the produced gases such as methane & CO<sub>2</sub> are released in open atmosphere directly. These wasted gases are good source of energy and the wasted sludge can be used as manure. The wastages of these products ultimately increase the unnecessary burden on environment. Typical composition of biogas is 55–75% methane and 25–50% carbon dioxide. In these bio-toilets, gases escape into the atmosphere and treated waste water is discharged after chlorination. (5)

**Table-1 Check List for Good Working of Bio Toilets: From technical review [4]**

S.No.	Items to be checked	Details of check	Corrective action
1.	Mounting/ Securing Arrangement	a. Check mounting bolts and J-brackets for any welding defects	Repair work to be done at washing/sick line as per condition
		b. Check condition of safety wire rope for proper securing and any damage of strands.	Replacement to be done if strands are damaged.

		<p>c. Check availability of chlorinetablets in chlorinator.</p> <p>d. Condition of chlorinator assembly for any tilling &amp; leakage from threads.</p>	<p>Ensure recharging by chlorine tablet when required.</p> <p>Repair work to be done at washing line /sick line if required.</p>
		<p>e. Check condition of flexible Rubber connector for any leakage, tearing and securing of clamp.</p>	<p>Repair /replacement to be doneas per condition.</p>
		<p>f. Check over flow for fecal material from Rubber gasket provided between tank body and top plate of Bio-tank instead of drain port of chlorinator.</p>	<p>Dismount the chlorinator at washing line, remove the choking at exit/outlet port and thus again mount the chlorinator.</p>
2.	Flushing Systems	<p>Functionality of flush valve, Flush pipe including fish tail forproper flushing without leakage.</p>	<p>Repair /replacement to be doneas per condition.</p>
3.	By-pass Mechanism	<p>Check By-pass mechanism by operation of paddle / Handle only after removal of choking if any.</p>	<p>Proper lubrication and replacement of spares if required.</p>
4.	Choking on arrival	<p>Choking of P-trap at inlet as wellas inside of it.</p>	<p>All gadgets as advised by Nodal Centre –DEE are to be used.</p>
5.	Foul Smell	<p>Any foul smell noticed after removal of choking and cleaningof toilet.</p>	<p>1. Topping up with bacteria with check after one week.</p> <p>2. Send the sample for lab testing after one week.</p>

## CONCLUSION

From the present study it can be concluded that, Bio toilet is an effective solution on wastewater emanating from the passenger coaches of Indian Railways. When human excrete comes in contact with bacteria, it get converted into methane, CO<sub>2</sub> and water through a series a step of anaerobic digestion.

The bio-toilet provided in trains, secured the environment and maintain aesthetic appearance of tracks for good working condition from the human excreta on the track. The corrosion cost by the fecal matters can be minimized by using bio-toilets.

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