

Hygiene Bio-Toilet Model for Energy Generation

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Abstract: On August 15, 1947, British paramountcy had left India with many wonders including railway which also called 'veins of our country' spread across every length and breadth of country. Indian Railways (IR) were being constantly criticized, as the discharges from toilets was laid on the tracks and this leads to environmental hazard. The toilet system in Indian Railways works in such a manner that the human faces and urine gets directly flushed on railway tracks through the hole on the floor of IR coaches. In current scenario, to deal with this issue, different systems like Controlled Discharge Toilet System (CDTS), Bio-toilet developed by IR engineers and DRDO biotechnologists, and Zero Discharge Toilet System (ZDTS) are extensively used. In this paper, a model of flush to energy is presented. The Bio-toilet system focuses on conversion of the toilet waste and biodegradable waste from station into energy which can be used for different purposes.

Keywords: Alert indicator, bio-toilet, flush to energy model, reservoir, sanitation of platform.

1 INTRODUCTION

In Asia, Indian Railways are the largest railway network. Indian Railways are owned and managed by the Ministry of Railways which works under the government of India since 1853. First circle was Mumbai to Thane. The Indian Railways must manage around 1, 60,000 toilets in 40,000 passenger coaches on day-to-day basis. The toilet in Indian Railways consists of a small-sized open type compartment in which the human faces and urine are directly ejaculated, and this leads to the corrosion of railway tracks and unhygienic conditions [1]. This is a win-win situation for the spread of different diseases, among which prominent being typhoid, cholera, diarrhea, hepatitis, parasitic diseases and other water-borne diseases. In case of the different parasitic diseases like tapeworm, hookworm, roundworm, and pinworm, main mode of transmission is human waste through the eggs, larvae and adult organism of parasites are being transmitted to different host, causing large environmental impact. While, tackling other issues for a period of 150 years by Indian Railways the issue of human fecal matter disposal on railway tracks remained unaddressed. The negligence of this issue by different authorities in the Indian Railway System over a period has led to a great matter of concern [2].

This paper proposes an approach-based model, which not only focuses on providing a solution to one of the world's biggest open toilet systems but also majorly focuses on conversion of the toilet waste into environment friendly energy and biogas energy. This biogas energy can be utilized further. It also provides a green path for the bio-degradable disposals such as leftover food, contaminated water and other as well.

1.1 Problem Statement

The different problems that arise due to the use of Conventional Toilet system are as follows-

- Ecological impact on the surrounding environment.
- Human Parasitic infections and other epidemic diseases.
- Platform cleaning and Corrosion, deterioration of railway track.
- Related sanitary issues.
- Hazardous to natural flora-fauna and their habitat.

These are some lacunas in the governing systems.

1.2 Objectives

The objectives are as listed below.

- Produce energy from human excreta and waste.
- Minimize the air pollution at railway platform and around the tracks
- To increase the life of a railway track.
- To reduce the capital and spend for the purpose of cleaning railway platform.
- Big boost to reduce the chances of acquiring any kind of health issues by the passengers, railway workers, railway staff, track man etc.

1.3 Scope

Scope of proposed model can be listed as,

- Prima facie comfort to passengers, track mans, staff member, and other activity related workers etc.
- Good solution in positive direction, waste to energy.
- Leveraging small amount of electricity requirements.

- Reduce the resources required for cleaning.
- Flexibly replaceable with conventional toilet system through some minor changes in their design.
- The whole system can be designed for manual based operation.
- The maintenance required for the smooth functioning of the system is negligible.
- The required cost of installation per toilet is minimum though it is one time investment.

1.4 Methodology

Methodology adapted, can be studied in the following heads,

- Examination and analysis of the conventionally used toilet system.
- Review of different toilet system, (Bio toilet system, and conventional toilet system).
- Investigating the different drawbacks in the conventional toilet system.
- Developing new system such that it overcomes the disadvantages in the previous system.
- Different manufacturing and developing aspects of the new system.
- Collection of material which are required for manufacturing new system.
- Manufacturing of different parts on unit.
- Testing factor of new invented system.
- The outcome of newly invented system.

This is a sequence to methodology that is adopted while the entire model assembling. The methodology adopted is shown in Fig. 1.

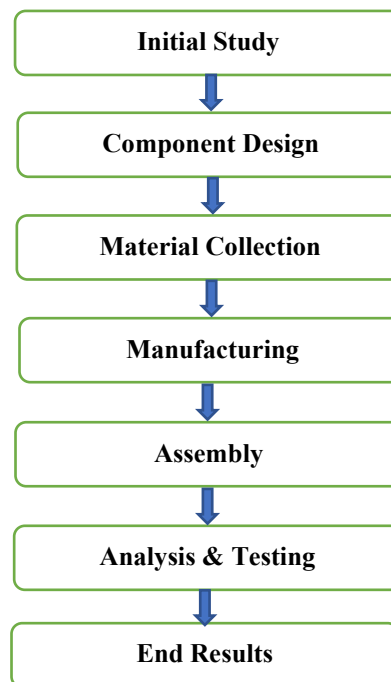


Fig. 1. Flow of Methodology

2 LITERATURE REVIEW

In 2012, Manoj H et al. Carried out a review of sanitation conditions in and around railways premises [3]. This work ironically focuses on the current grim situation of the Indian railway, and this also proposes the solution to this. Also talk about role of government, passenger and public. it gives idea of sanitary protection for installation such as reservoirs, overhead tank. To accomplish a complete success the sanitation of Indian Railways is one of the most important aspects and it's the need of hour. The purpose of sanitation in Indian Railways can be achieved through the combined efforts from passenger as well as the railway administration. The most important factor for achieving the goal of complete sanitation is the cooperation shown by the passengers with the administration otherwise it is hard to achieve the goal of sanitation.

In 2013, Virendra Kumar Yadav et al. presented a flush-to-energy model for Indian Railways [4]. This model contains, TST (Temporary Storage Tank), Open/Close signal indicator, Flush Expert Device (FED), septic tanks, Biogas Plant. First step includes the installation of TST and FED in all the railway coaches. Also, there is a need to attach the toilet outlet (hole in the floor as in Indian Railway's toilet system) to inlet of TST. Outlet of TST is controlled by FED. The coaches in the railways consist of Open/Close signal receiver. Septic tanks which work on the open and close mechanism are controlled by Septic Tank Expert Device (STED). The outlet of septic tank is being attached to Biogas plant. There are open/close indicators at the two ends of the septic tank.

In 2017, Papale K.S. et al. proposed a modern toilet system [5]. In this proposed model when railway engine is arriving at platform, the reservoirs of modern toilet system are coming under working by using the speed of railway shaft and the human wastes are store in main reservoir till the train doesn't depart from the platform. At the time of departure of the railway from the platform the human wastes are discharge with chlorine action at a certain distance from end of the platform. In general system only deals with speed of train. The system involves different things like governor assembly, slipping clutch, followers, main reservoir, chlorine reservoir, discharge control unit, different links etc.

Structurally the governor is externally clamped on main shaft of train. Slipping clutch assembly is attached to the movable end of governor. The followers are directly connected to the slipping clutch. Both main discharge control unit and chlorine control unit are attached to the slipping clutch through the flexible link. In case of working condition, when train is started to move from platform and after achieving 26.3318 km/hr speed the reservoir are slowly open up to 33.6619 km/hr and hence the stored human waste is discharge at some distance from platform with chlorine action. Morally it is speed dependent mechanism. Many proposals are made which can be categorized into modifications or improvements of the schemes presented in this section [6]-[13].

3 PROPOSED IDEOLOGY

Proposed ideology can be elaborated in the two heads. Construction insight and modus operandi respectively and is presented in this section.

3.1 Construction Insight

It is very simple and retrofitted ideology in construction perspective. At very first, the reservoir as so connected each other so that the level of each boogie reservoir remains same and is done with the specialized pipe system. Reservoir also have the sensors which shows the high-low indicator at the deck for thence. He /she can discharge it by ON the discharge flow. Construction contains the components like High-low indicator, Bio digester tank and desired pipe system. Food collector ironically used to collect food waste and biodegradables. Ideal construction methodology is depicted in given figures.

Section A: Railway toilet system (Refer Fig. 2).

Section B: Platform food collector system (Refer Fig. 3)

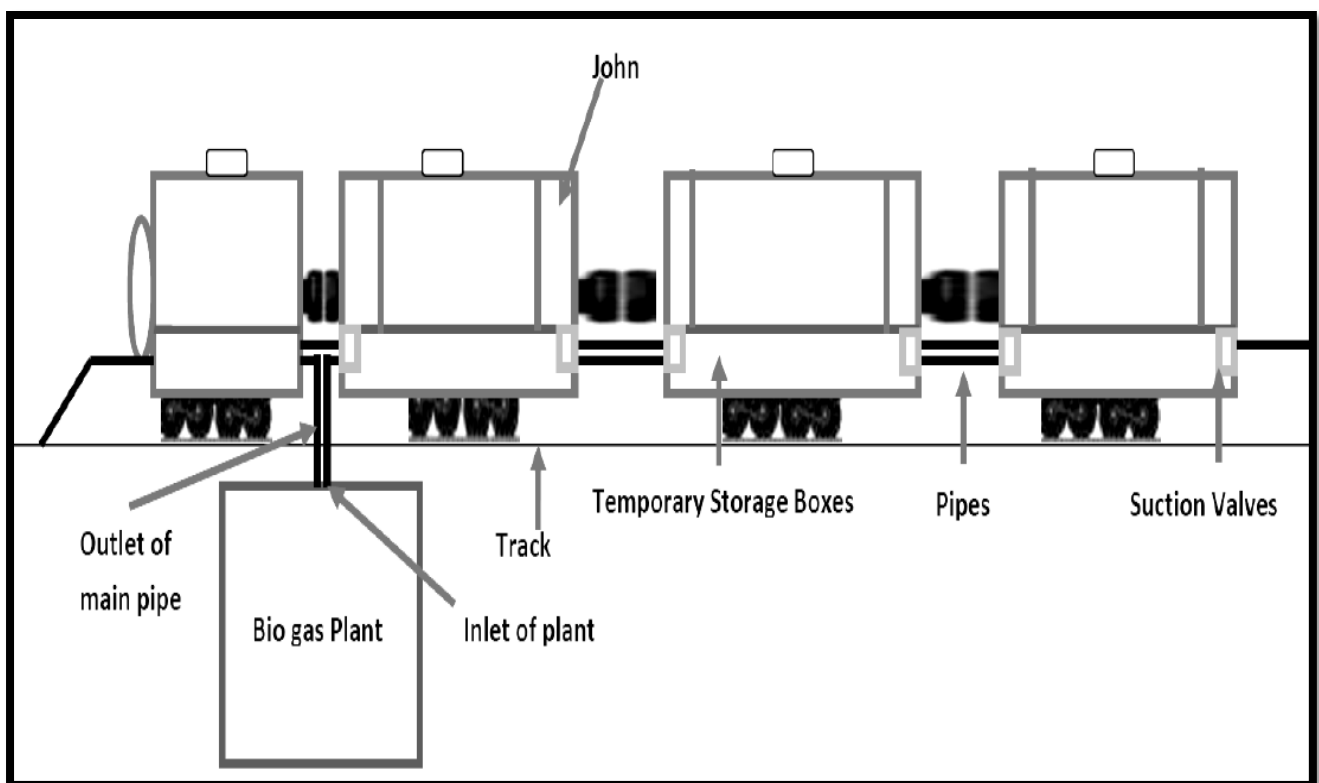


Fig. 2. Section A. Railway Toilet system

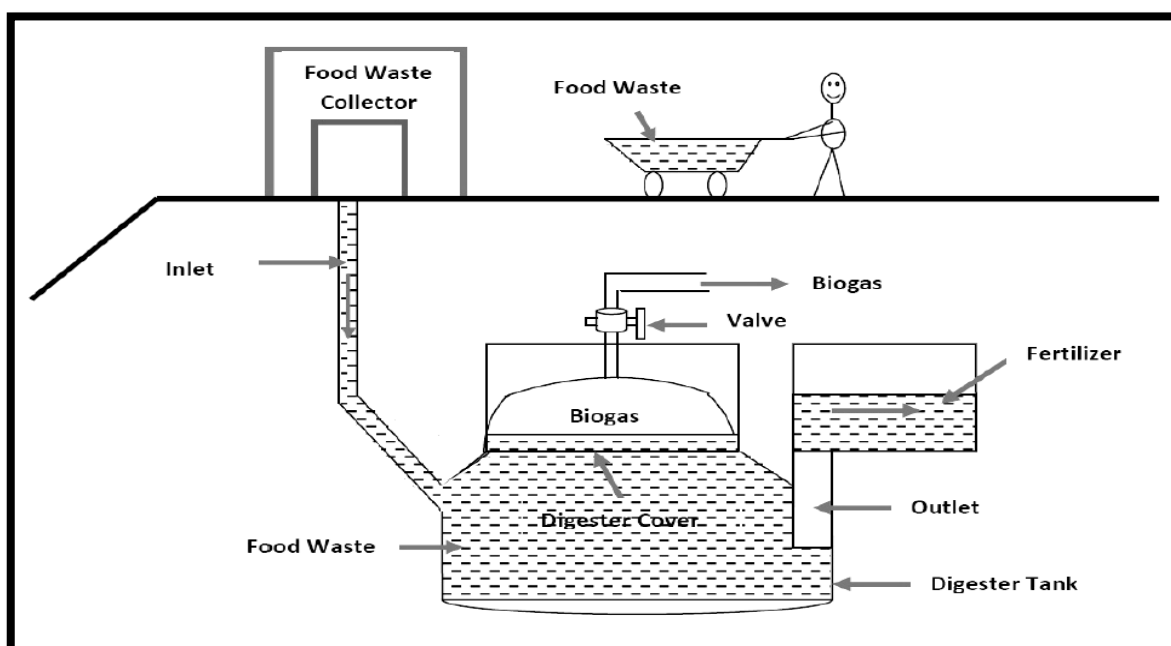


Fig. 3. Section B Platform food collector

3.2 Modus operandi of proposed model

Working of model is very simple as its construction. As, after the frequent use of railway toilet, the reservoir gets completely filled and it shows as the high mark on indicator. Which is installed at deck of railway i.e., cabin. By putting discharge mode ON manually, all the accumulated faecal material flows automatically into the digester tank through the subsequent inlet compartment. This entire process accompanied by suction. Further the faecal material supplied to bio digester tank it then converts it into biogas for the cooking and other purpose, remain sludge as fertilizer and left-over by-product water as fertilized water, which is immensely helpful for plants and vegetation.

In the same way food collector collect the left food and other biodegradables from the station and further goes through the same process as the faecal material travel. In this way the material we think as waste can give energy without very much trouble. Refer the Fig. 4 for the flow of working process and Fig. 5 for the combine assembly.

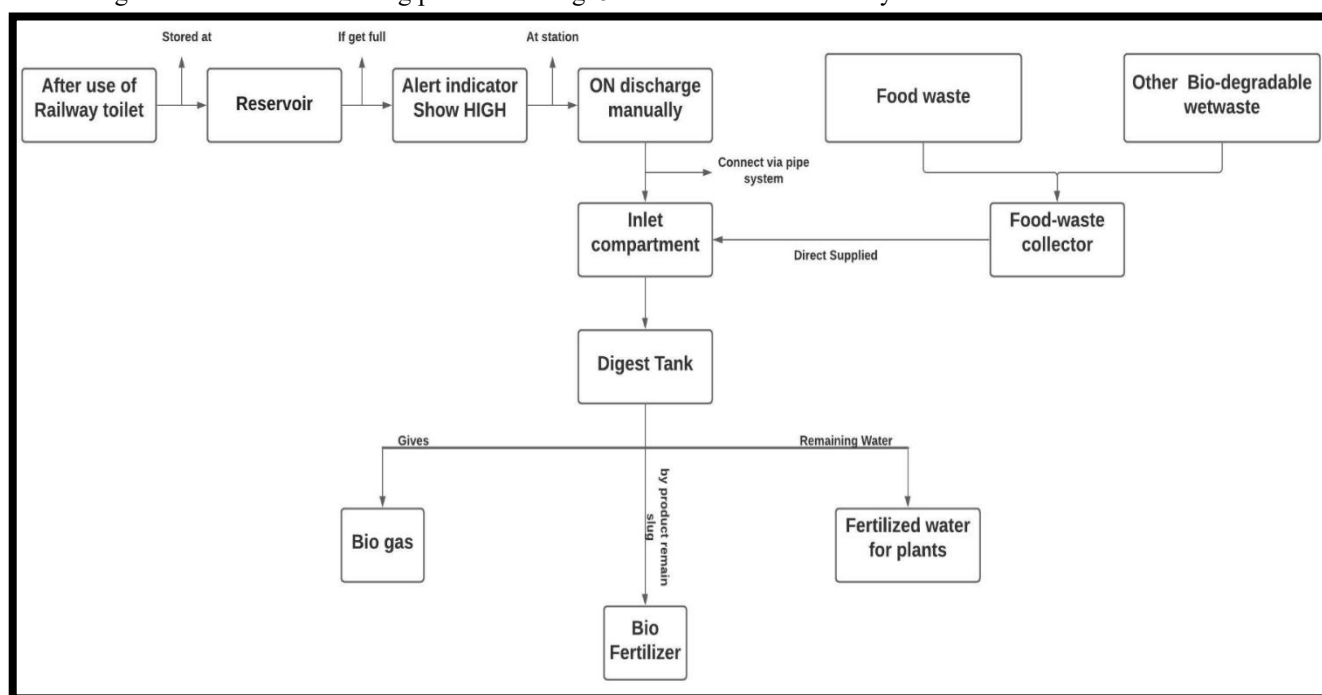


Fig. 4. Working Process

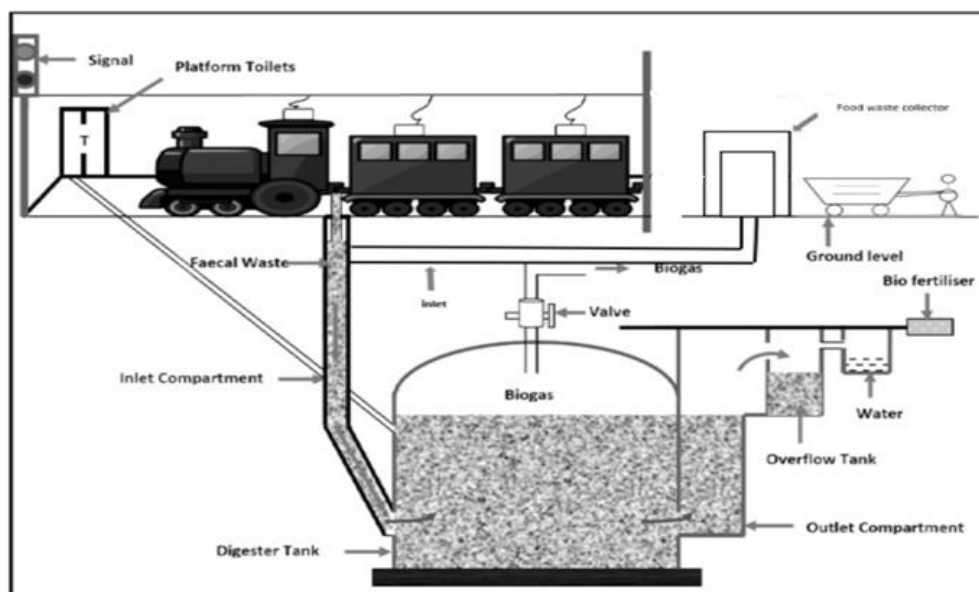


Fig. 5. Proposed model

4 DISCUSSION

Some pros of the proposed mechanisms can be reflected in the following heads and are the key driver for the future productivity.

- Environment friendly.
- Preventing damages to tracks due to corrosion.
- Improved aesthetics at Railway Stations.
- Require less maintenance.
- Simple in design.
- Easier Retro fitment on existing coaches in service.
- Can be in operation up to years together.

This mechanism has very few disadvantages as compared to other, this can be cited as

- Requirement of skilled workforce.
- Large scale of Space and other infrastructure required.
- Require Vigilance body.

The proposed model may be further improved in the following manner.

- End-to-end computerization can be adopted.
- Size and infrastructure space consumption can be reduced.
- Efficiency can be improved up to 90%.
- Efforts can be done to increase reservoir capacity.
- Required skilled work force can be reduced.
- High end 21st century skill and technologies can be fetched.
- Station's other related sanitary hotspots need to be address on war-footing basis

5 CONCLUSIONS

This is an eco-friendly process with one time investment that can ace the very severe problem which is hampering the public at large. Proposed model mainly focuses on the production of energy in biogas form by conversion of faecal matter and food waste into energy. Along with the production of energy, fertilizers can also be produced through this model which can be used in different agricultural practices. The concept used in this model not only focuses on maintenance of sanitary condition but also on the production of different sources of energy production.

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ETHICS STATEMENT

This study did not involve human or animal subjects and, therefore, did not require ethical approval.

STATEMENT OF CONFLICT OF INTERESTS

The authors declare no conflicts of interest related to this study.

LICENSING

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