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THE IMPACT OF GREEN TECHNOLOGY ON INDIAN RAILWAYS WITH RESPECT TO RETROFITTING OF BIO TOILETS

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Abstract
Technology is all around us and growing every day. Green technology is pretty new concept, in respect to the entire timeline of technology. A new way of thinking that preserves our natural resources. By reducing the costs of environmental protection, technological change is important for promoting green growth. This entails both the creation of new technologies and more widespread deployment of existing green technologies.

The paper overviews the preface of green technology in reference to the retrofitting of bio-toilets in Indian railway. It focuses on how this technology has transformed Indian sanitation and to some extent coping up with the two severe effects of industrial revolution, pollution and sickness.

The paper is exploratory in nature, based on secondary data collected from various newspapers, articles, magazines and published reports and would be beneficial to researchers.

Keywords – Retrofitting, Bio Toilets, Industrial Revolution.

1. Introduction

1.1 GREEN CONCEPT

Green technology is the means of energy production that is environmental friendly or to a technology in itself that is considered less harmful than technologies that are more traditional, hence there are products that are being produced which produce less carbon dioxide, or require less fuel to run them. There are also fewer chemicals in cleaning supplies which eventually means fewer chemicals that are being washed down the drain. This in turn makes them eco friendly.

It is thus, the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement.

According to World health organisation and UNICEF estimates that 60 percent of Indian population defecates in the open and annually 2.4 million Indian children die of diarrhoea, caused by open defecation[1]. Government of India spends INR 12 billion on rectifying ailments resulting from improper sanitation.78 percent girls in rural India drop out of school owing to inadequate sanitation facilities. Even Indian Railways spends INR 350 Crore annually on rectifying rail corrosion[2].

1.2 Bio-Toilets or Bio Digesters

Bio-Toilet technology is based on anaerobic biodegradation of organic waste by unique microbial consortium and works at a wide temperature range.

Bio-Digester is a decomposition mechanized toilet system which decomposes Human Excretory Waste in the digester tank using specific high graded bacteria further converting it into methane and water, discharged further to the desired surface. The Bio-digester is total maintenance-free system, which does not require any sewage system.

The inoculums bacteria used in this bio-digester procreate & generate new bacteria in an anaerobic environment and do not require repeat dosing. The bacterial consortium degrades night soil at temp as low as minus 20 degree Celsius and produces colourless, odourless and inflammable gas containing 50 percent to 70 percent methane.

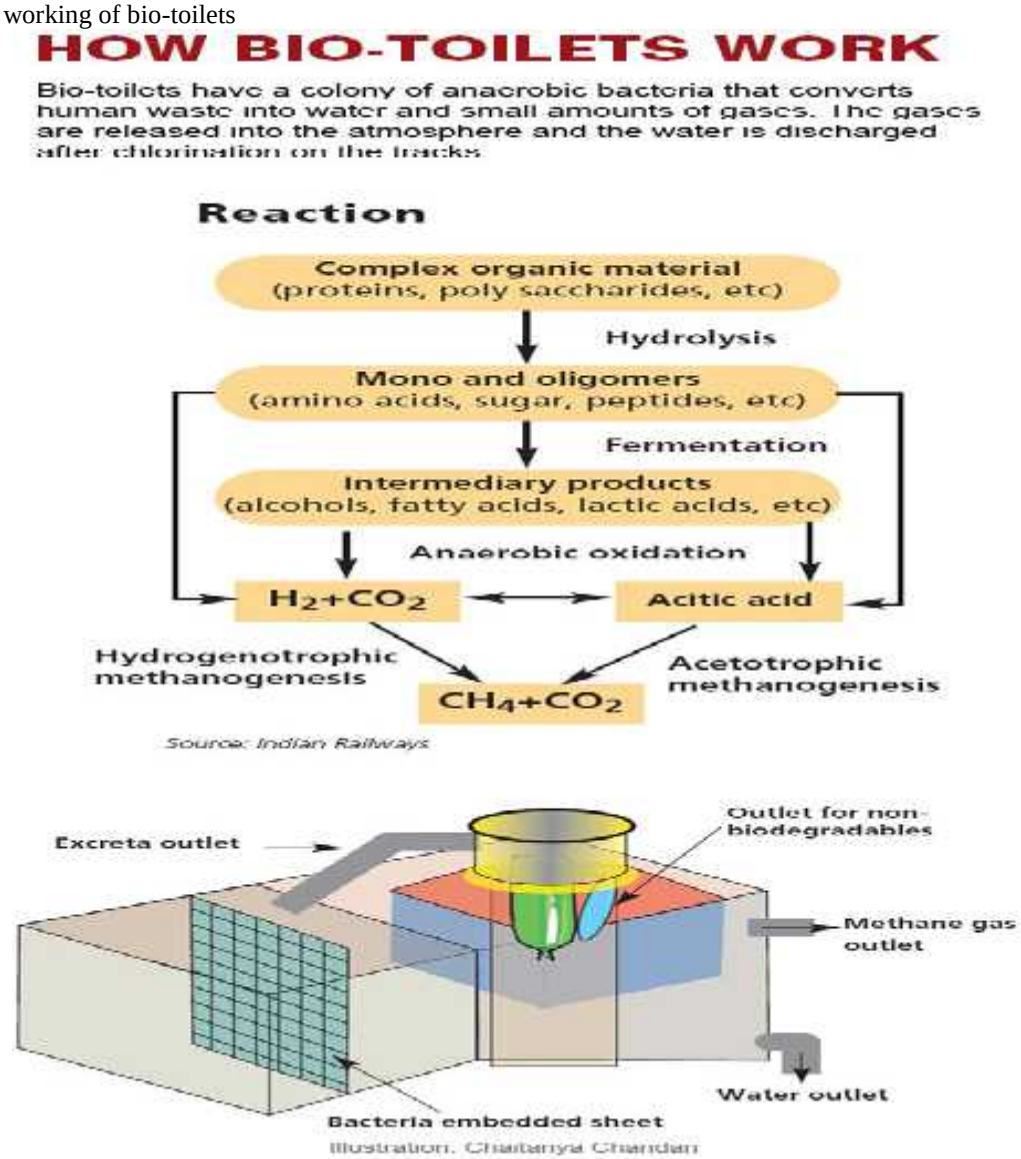
This bacterial consortium has been made through acclimatization, enrichment and bio-augmentation of cold-active bacteria collected from Antarctica and the other low temperature areas.

[1] *www.unicef.org*
[2] *www.bio-toilet.org*

Bio-digesters have three anaerobic chambers that treat Human wastes effectively, and don't require any cleaning or emptying the tank because of its unique systematic structural arrangements.

To start with the very first chamber, where in, the Human wastes arrive from the toilet's outlet, consequently the solids drop to the bottom of the tank because of the systematic structure of the bio-digester tank and the high graded pre residing bacteria (anaerobic bacteria, which can survive in the absence of oxygen) rushes eating away organic waste decomposing.
When this chamber is filled, the water overflows to the second chamber where more of the same happens, except at this time most of the biological/solid/slugged matter has been left in the first chamber. When the water overflows into the third chamber, it is almost 90 percent clean and hence the final stage of digestion takes place. The treatment, the task of cleansing water is continuously carried forward from the start to the end point, till the water exits the bio-digester. When the treated water finally comes out from the bio-digester and into our irrigation pipelines (optional if required), it is 98 percent clean and free from entire pathogens. This water is thus safe to be used for underground irrigation via pipes buried below the surface. However, the treated water should not be used for human or animal consumption, or for household cleaning without going through additional treatment.

Diagram 1.2 a working of bio-toilets



Source: secondary data

1.3 Significance Of Bio Toilets

Bio-toilet digests organic solids in an ecological way. It prevents human waste and untreated water from contaminating groundwater and offers an alternative to dumping of wastes into rivers, lakes and fields in rural and semi-rural areas where there are no sewage systems.

The effluent can be used to water plants. The effluent is cleaner, more effective and easier to use than a septic tank because it does not need to be further cleaned or emptied.
The effluent is odourless, non obnoxious, colourless as compared to the end products of the toilets being used these days.

2. Eco Friendly Approach

Indian Railways did make endeavours for environmental friendly green toilet in passenger coaches. Ministry of Rural Development announced policy, which envisages total sanitation and elimination of open defecation all over the country. Green toilets aim at zero defecation on the ground. Thus, not only making it a likable sight at stations but also preventing damage to bogie parts and tracks by way of corrosion. Faecal matter on tracks is one of the biggest causes of corrosion.
IR and DRDO did sign a Memorandum of Understanding for development of Bacteria for Green toilet. The new toilet-technology also promised to keep up with not-so-disciplined Indian toilet habits, separating before disposal the non-degradable waste that passengers mostly flush in toilets. RCF did developed environmental friendly green toilets and turned out 571coaches equipped with 1390 green toilets.

The production plan 2013-14, was that that all ICF design coaches shall be turned out fitted with bio-toilets as per RDSO approved plan. Nearly 150 railway coaches were retrofitted with bio-toilets every year at the Central Workshop at Ashokapuram in the city. This was a part of the long-term drive to phase out conventional toilets in the next 5 years in all the coaches across Indian Railways in a bid to go environmental-friendly. Till February 2015, 23 coaches were fitted with bio-toilets approved by the Research Designs and Standards Organisation (RDSO) Lucknow[3].

Each unit weighs about 250 kilogram and retrofitting each coach with four such units means adding one tone of weight to the coach which calls for strengthening the lower frame of the bogie.

More bio-toilets have been fitted into coaches this year than the total bio-toilets fitted in the last three years. According to an IR source, the number of bio-toilets fitted in passenger train coaches from April to July this year was 2,285, against 1,337 bio-toilets fitted during 2012-13, 169 during 2011-12, and 57 during 2010-11[4].

According to Nitin Chowdhary, executive Director, Mechanical Engineering Development, and Railway Board "The IR has been trying out various technologies and designs for a long time to avoid corrosion of tracks due to faecal matter." Chowdhury explains that the first effort towards proper disposal of human waste on passenger trains was made in 1975.

Subsequently, it was experimented with technologies using aerobic bacteria, imported from a firm in the US, solid-liquid waste separation, and controlled discharge systems. With this meeting started the association with the DRDO that culminated in the development of the bio toilet.

3. Sustainable Solution to Indian Sanitation

The first bio toilet fitted train, Gwalior-Varanasi Bundelkhand Express, has been running since January 2011. The bio-toilets in the Gwalior express ensure that the undercarriage was clean and without any faecal depositions. The other advantage was that single bacteria recharge worked for nearly a year. The anaerobic bacteria used in the green toilets can withstand extreme climates and common disinfectants. They are resistant to normal cleaning solutions used by the railways.

The bacteria used in the bio-toilet have been collected and analysed by DRDO from Antarctica and the efficiency of this

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ttp://www.rcf.indianrailways.gov.in/works/uploads/files/RCF_design_Furnishing/New%20Design%20and%20Developments.pdf
ICF- Integral coach factory
RDSO- research design and standard organisation
[4] *March 27, 2015, The Hindu*
DRDO –Defense research and development organization

system has been tested in extreme climates and conditions. The bacterial inoculum used by the IR for initiating the bio-degradation process is a combination of different groups of bacteria involved in the decomposition of cow dung and human excreta. Typical composition of biogas is 55–75 per cent methane and 25–50 per cent carbon dioxide. The pH value of the final discharge is near-neutral (approximately 6.5-7.5) in most of the cases; it may vary depending upon the number of passengers using the bio toilets. According to DRDO, microbial inoculum contains anaerobic bacteria belonging to four different clusters namely hydrolytic, acidogenic, acetogenic and methanogenic groups[5].

The cost of a single module of bio toilet is between Rs 75,000 and Rs 80,000. The retrofitting bio-toilets is a challenge and can be expensive. The welding required to fix these tanks and brackets is of exacting standards. The old parts on which this assembly has to be welded also need to be removed if they are corroded, which is a labour-intensive job and can be done only in specialised workshops. Hence the cost of retro fitment goes up substantially depending on the quantum of work involved and quantity of parts needing removal and replacement. However, the decision to adopt bio-toilets is not cost based, but to make our stations and tracks clean. The bio-toilet tanks or digesters are made of stainless steel and have a dimension of 1,150 mm x 720 mm x 540 mm. The weight of empty tank is 110 kg and that of full tank is 410 kg. The digester tank has multiple chambers that enable efficient biological degradation by providing maximum pathway to anaerobic bacteria. The digester has a provision for bacteria colonisation to cope with sudden washouts by accidental pouring of large amounts of water in the toilet.

It also takes care of the occasional adverse conditions created by the accidental use of excessive detergents and antiseptics. DRDO thinks the design is simple and the system, once installed, can be in operation for years.

The maintenance of bio-toilets includes visual inspection of the toilets, clearing of the toilet chute in case of chocking and charging of chlorine tablets in the chlorinator. The bio toilets, which are welded to the passenger coaches, have an inlet for human excreta and an outlet for biogas.

4. Conclusion

Currently over 4,000 bio-toilets were in used in trains. With a view to completely switch over to environment-friendly toilets by 2021-22, all new coaches were fitted with either bio toilet systems or brackets which can hold bio toilets. Bio-toilets had faced a lot of criticism during the trial phase on the systems inability to treat the waste fast enough. Bio toilets, in the long run, will be cleaner and economical.

IR is working on designs for flushing to keep the area around the toilet seat clean. Apart from this, the toilets are frequently cleaned by air-water jets at Clean Train Stations. The success of the model rests on the cooperation of passengers, who are expected not to use the toilet pan as a garbage bin. Bio-toilets get easily clogged by plastic bottles, tea cups, cloths, sanitary napkin, nappies, plastic bags and gutkha pouches.

Railways have identified toilets as one of the 17 special areas where 100 percent foreign and private investment can bring about major investments.

According to the guidelines approved by the government under its Foreign Direct Investment policy, 100 percent Foreign Direct Investment can be utilised in facilities like cleaning up trains and installation of bio toilets in passenger coaches and setting up of mechanised laundry facilities.

It is a step forward to invite private and foreign investment in the Railways as new areas have been identified for Foreign Direct Investment.

A committee constituted by Railway Ministry to finalise the policy has also suggested a set of business models to attract investments. Besides bio toilets, cleaning operation and mechanised laundries, the areas identified by the committee for Foreign Direct Investment include construction, maintenance and operation facilities to supply non-conventional sources of energy to the Railways, installation and maintenance of bio-toilets in passenger trains, setting up of technical training institutes, testing facilities and laboratories and providing technological solutions to improve safety.

[5] *Ndtv September 13, 2015 12:19 IST*
"Indian Railways to Launch Trial Run of Vacuum Toilets Tomorrow"

Earlier, the government had relaxed the Foreign Direct Investment norms permitting 100 percent investment in rail projects, such as high-speed trains, suburban service, dedicated freight corridors, and freight and passenger terminals.

The Foreign Direct Investment is also being permitted for rail route electrification, signalling system and logistics parks.
The committee has suggested three business models for high-speed train projects including projects where there are limits on operations and a firm wants to invest in upgrading the existing rail network for speed above 120 km per hour or semi-high speed network.

In dedicated freight lines, the Railways have permitted operations by investors, subject to certain conditions.The government has now allowed mechanised laundry facilities to be set up on public-private partnership (PPP) basis. It also suggested some freight lines - new and doubling - that could be taken up on PPP basis.

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