CASE STUDY

FAECAL SLUDGE & SEPTAGE MANAGEMENT IN CITIES: COMPARATIVE ASSESSMENT OF FSSM PLANT OF WAI CITY MAHARASHTRA, BHUBANESWAR & PURI CITIES OF ODISHA

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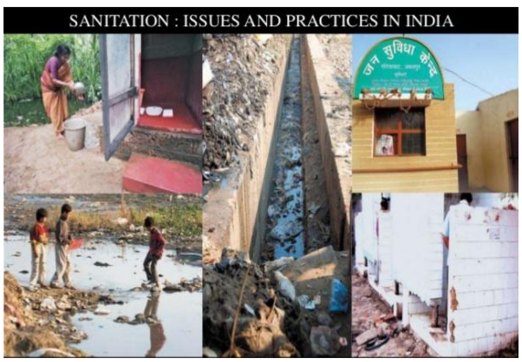
Background:

According to Census 2011, India's urban population is 377 million or 31% of the total population, which is expected to increase to 600 million by 2031. The Census 2011 also showed that in 4,041 statutory towns, 7.90 million households (HHs) do not have access to toilets and defecate in the open. As per Global level data only 5% of fecal sludge is properly treated. Nearly 500 million people in India, using non sewered systems, do not have access to any treatment of fecal sludge. Untreated faecal sludge and septage management from towns and cities is one of the major causes of surface and ground water pollution in India. The Increase in access to sanitation under Swachh Bharat Mission brought about an evident need to address the emerging liquid waste management challenges. In India, a majority of the household depend on onsite sanitation facilities wherein, safe management of human waste, which includes its safe containment, transport, treatment and disposal, is of utmost importance to make our cities healthy and livable. Most on-site sanitation systems (OSS) are emptied manually in absence of suitable facilities. Ideally a septic tank system should be desludged every 2-5 years. However surveys conducted in a few cities Maharashtra suggest that septic tanks/pits are emptied only once in 8 to 10 years and only when they overflow. As per the Prohibition of Employment as Manual Scavengers (and their rehabilitation)Act,2013,manual cleaning/emptying of pit toilets and septic tanks is prohibited. But ignorance towards maintenance and operational conditions often results in accumulation of organic sludge, reduction in effective volume and hydraulic overloading which ultimately causes the system failure and release of partially treated or untreated septage from the septic tank. Private operators often do not transport and dispose of septage several kilometres away from human settlements and instead dump it in drains, waterways, open land, and agricultural fields. Manual de-sludgers working in inaccessible low-income areas and squatter settlements, usually deposit the septage within the family's compound, nearby lanes, drains, open land or waterways without permits or any safety regulations.



Indiscriminate discharge of untreated domestic/municipal wastewater has resulted in contamination of 75% of all surface water across India (NUSP, 2008). This has imposed significant public health and environmental costs to urban areas. According to a study by World Bank, the total economic impacts of inadequate sanitation in India is estimated to be Rs 2.44 trillion (US $53.8 billion) a year which is equivalent to 6.4 per cent of India's GDP in 2006 (USAID, 2010). Septic tanks require de-sludging at regular intervals in accordance with its design and capacity. Often only when a tank gets clogged and filled beyond its holding capacity that de-sludging is done. The overflow from the tank finds it way into any nearest waterways or land surface and pollutes it. The effluent and sludge from septic tanks are often rich in phosphates and nitrates. The effluents lead to saturation of surface soil and water bodies with nutrients posing a threat of eutrophication to the surface waters. People and animals in contact with these contaminated areas are susceptible to infections. It also pollutes the groundwater, when the sludge percolates. The leachate from the unmanaged septage virtually disposed on the subsurface can pollute the ground water. Communities coming in contact with these contaminated soil or water become susceptible to infections and water borne diseases. Furthermore, rising urban population and increasing access to sanitation exert pressure on the existing sewerage management systems. Recognizing the evident need to address the challenges, government mandated initiatives such as the AMRUT which was introduced with funds earmarked specifically to finance various programmatic interventions pertaining to liquid waste management among other interventions. Beside the conventional sewer system, initiatives like AMRUT took a step further to address the liquid waste management challenges by adopting complementary approaches such as FSSM for Septage management in areas lacking sewerage System. India's bigger cities have large, centralized sewerage systems with vast underground pipelines, pumping stations and huge treatment plants. These systems are expensive to build and even more expensive to operate effectively, as they require continuous power, a large amount of water, skilled operators and extensive electro-mechanical maintenance. For instance FSSM was promoted as an alternative solution for efficient liquid waste management in small and medium towns where setting up sewer networks seemed unviable due to several reasons such as high cost, longer and complex construction phase and less density of population. Keeping in view Ministry of Housing and Urban Affairs Government of India has endorsed National Policy on Faecal Sludge and Septage Management (FSSM) that induces and sensitizes national, state and local bodies to decentralized sanitation approaches, and propositions such approaches as a viable alternative to centralized sewerage systems where appropriate.

In this above context Government of Maharashtra and Odisha has recognized the significance of adopting a comprehensive approach to FSSM in urban areas. A serious cognizance of the adverse impact of untreated faecal sludge and septage on major rivers flowing across main towns of Maharashtra and Odisha from where drinking water is drawn for treatment and supply triggered the need for safe management of septage. Government of Odisha is investing to construct SeTPs and FSTPs to treat the faecal waste. The nine AMRUT towns which have approvals to construct SeTPs and FSTPs in six towns of Berhampur, Bhubaneswar, Dhenkanal, Puri, Rourkela and Sambalpur are being commissioned.

In the present case study is an effort to document the functional FSTPs in selected four cities from 3 three different states namely Jhansi from Uttar Pradesh, Puri and Bhubaneswar from Odisha and Wai city from Maharashtra. Brief details of each selected FSTP along with city profile is mention bellows:

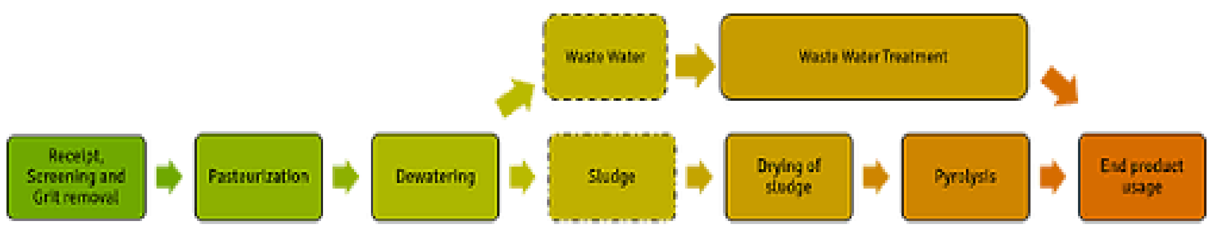
CITY WAI

Wai city class C council located 95 kms from Pune and is one of the major shooting destinations for the Indian film industry and also knows as a small pilgrim city in Satara district of Maharashtra, situated along the River Krishna. According to Census 2011 the population of city is 36025 and total number of household is 7580 out of 5143 households have toilets on premises, 2300 households are dependent on on community toilets and 135 households defecate in the open. Wai has already become ODF+ by implementing Faecal Sludge and Septage Management Plan. More than 80 % of households have individual household toilets. The rest have access to well maintain community toilets. The city does not have any underground drainage/ Sewerage system and toilets in city are connected to septic tanks and pit latrines.

The fecal waste is discharged with high moisture levels of upto 95%. Pyrolyzing fecal waste with a limited oxygen supply destroys all pathogens present in human waste, and provides fast volume and mass reduction, a net energy output (heat and electricity), and a usable end product – biochar, which provides excellent soil enrichment when used with compost. The community scale fecal sludge and septage processor aims to sanitize fecal waste, dewatering and pyrolyzing the sludge for meeting the energy requirement of the process for a capacity of 15,000 lpd, in urban Indian environments, as a solution for septage management for non-sewered small cities and towns in India.

In the above context the Bill & Melinda Gates Foundation in partnership with Tide Technocrats Private Limited and Biomass Controls LLC in November 2016, for working on product development and commercialization planning of the community scale fecal sludge septage treatment unit. As part of this project, research, development and testing unit installed in Wai, Maharashtra for field testing. The unit is extensively working for testing of fecal sludge and septage on a daily basis, to assess reliability, functionality and establish O&M protocols. The modularized design allows for the unit to be suitable for low space operations, rapid deployment and incremental growth management.

Community Scale Fecal Sludge and Septage Processor – Stages



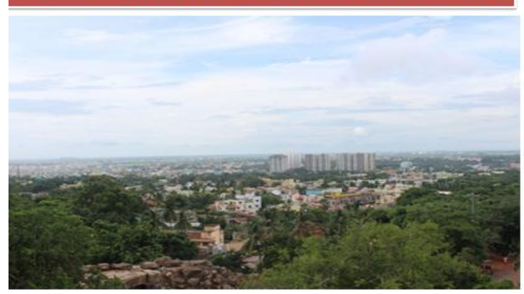
FAECAL SLUDGE TREATMENT TECHNOLOGY	
Technology	Pyrolysis – Non-Biological
Working Principle	The working principle of pyrolysis is thermochemical decomposition of organic material at elevated temperatures in the presence of controlled oxygen (pyrolysis) to efficiently convert sludge to biochar without external power.
Key features	• The system comprises of grit removal, pasteurization, solid-liquid separation, dryer, pyrolizer, heat exchanger and dewatered effluent treatment system. These different subsystems integrated together form a complete plant that can process Faecal sludge to biochar. • The counter flow heat exchanger recuperates the heat generated from pyrolysis and is reused back within the system. No external heat source is required enabling sustained operations • The system is equipped with online temperature monitoring systems optimizing the energy consumption and ensuring the pasteurization. • The biochar and pasteurized liquid are the products from the process.
Performance	• The process outputs meet the prescribed Indian norms for sewage and international norms for Faecal sludge. • The process outputs are completely biosafe for use

Applicability	• Applicable for treatment of Faecal sludge, STP sludge or sludges with organic content
Operations & Maintenance	• Cleaning of screening and grit units • Regular removal of Biochar
Strengths	• Automated system with no direct contact with faecal sludge • Suitable for all weather conditions • The products from the process including dewatered effluent are biosafe for reuse including food nursery • Modular System which can be easily scalable • Suitable for installation within the city having unique physical appearance • Fast deployment, with very low footprint
Challenges	• Varied septage characteristics pose depend for external thermal energy needs

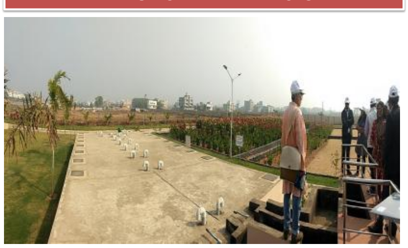
Technology Installed Location Details		
Installed Location	Status	Technology Provider
Warangal (TS), Wai(MH)	Operational	TIDE Technocrats, Bengaluru, Karnataka
Capacity	Area Requirement	Manpower
70 KLD	10,000 sft	3 members/ shift (Two shift
Capital cost and Operational cost	Capital Cost- Rs 8 lacs/KLD Annual Operational Cost- Rs. 65,000 to 1,00,000/KLD	
Additional Features	• Sanitation Resource Centre and green house of food and non-food nursery plants for reusing the treated liquid has been planned at all the installed plant locations Primarily mechanical; ranges from 90 days to 120 days	

CITY BHUBANESWAR

CITY OF BHUBANESWAR FROM KHANDAGIRI HILL



ANAEROBIC BAFFLED REACTOR



Bhubaneswar is the capital of the Indian state of Odisha. It is the largest city in Odisha and is a centre of economic and cultural importance in Eastern India.Along with the old town, the region historically was often depicted as Ekamra Khetra (Temple City). With the diverse ranges of

SCREENING CHAMBER

heritage resources, it showcases significant sacred cultural landscape components which have evolved with the support of available natural resource base and cultural trigger. Bhubaneswar is in Khordha district of Odisha. It is in the eastern coastal plains, along the axis of the Eastern Ghats mountains. The city has an average altitude of 45 m (148 ft) above sea level. It lies southwest of the Mahanadi River that forms the northern boundary of Bhubaneswar metropolitan area, within its delta. As per the 2011 census of India, Bhubaneswar had a population of 837,737 which is accompanied by challenges of providing people of the town with good quality basic amenities such as water and sanitation in this aspects 75 KLD SeTP is established , which treats both solid and liquid parts of the septage in an integrated manner. The SeTP is designed to treat the liquid part of the septage using DEWATS technology. This is a gravity flow-based system, where septage collected through cesspool emptier trucks is discharged to the receiving chamber from where it flows to different units by gravity. The technology requires least mechanical and electrical interventions to run the process and is cost effective as compared to other technologies. Additionally, the solar photovoltaic (PV) Panels installed to generate grid connected solar power to make the plant energy surplus. The SeTP covers an area of 2.47 acres out of which 1.3 acres have been utilized for landscaping and plantation. This is a unique initiative that not only enhances the aesthetics of the plant but is also expected to garner support of citizens and raise awareness on importance off treating faecal sludge and septage. The treated water is used for watering the trees and lawns in the SeTP Campus. In addition, a solar plant of 10 KW capacities has been installed and made operational, which is an on-grid system. The surplus power can generate revenue for the plant.

Treatment Technology: Solid liquid separation, liquid fraction treatment through DEWATS technology & Solid fraction dewatered in sludge drying bed for further use.

PLANTED GRAVEL FILTER

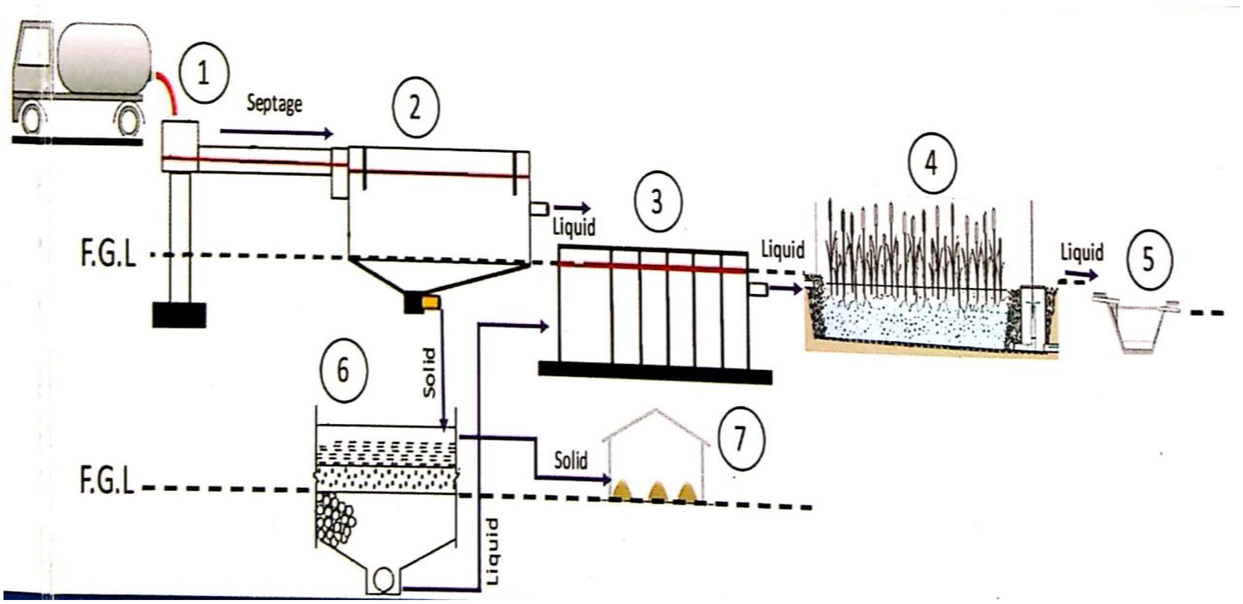
ADMIN CUM LAB BUILDING WITH SOLAR PANELS

SETTLING CUM THICKENING TANK

POLISHING POND WITH AERATION

SLUDGE DRYING BED WITH SHED

Treatment Process Flow Diagram

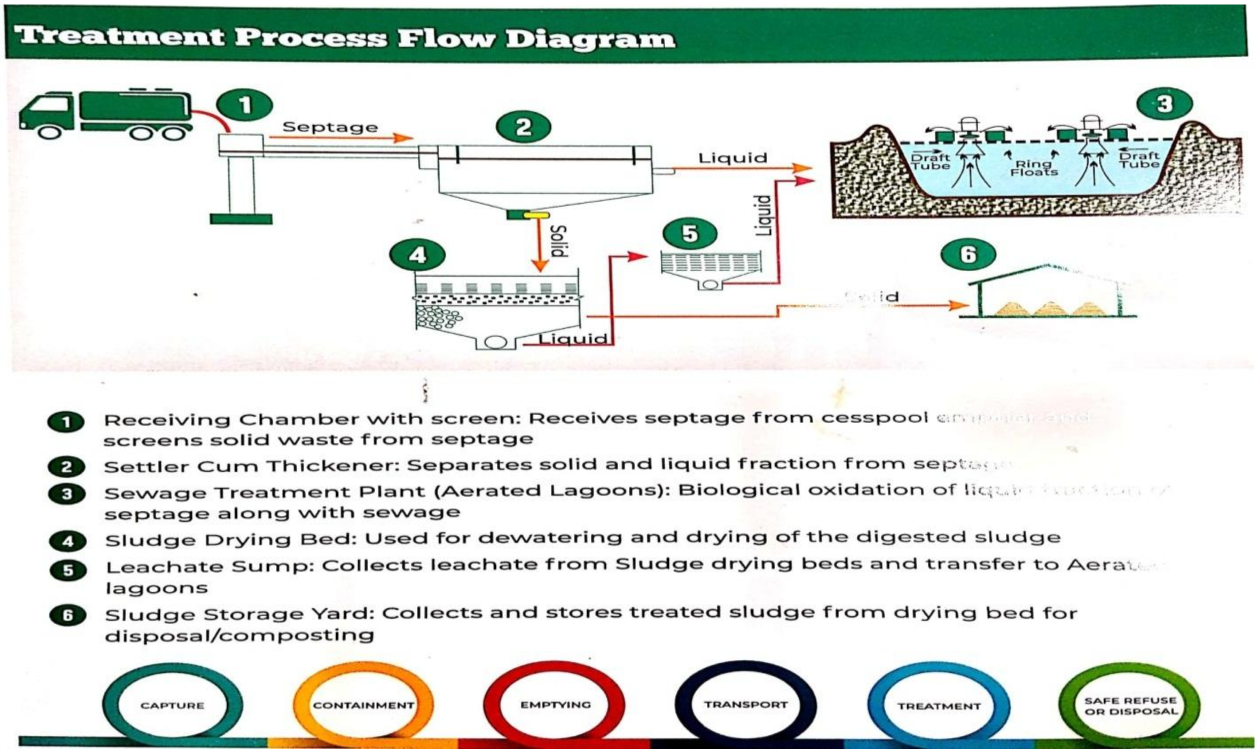


	Component	Description
1	Receiving chamber with screen	Receives septage from cesspool emptier vehicle and screens solid waste from the septage
2	Settler-cum-thickener	Separates solid and liquid fraction from septage
3	Anaerobic Settler Anaerobic Baffle Reactor (ABR) Anaerobic Filter	Removes settleable solid and anaerobic digestion of organic fraction of septage
4	Planted Gravel Filter (PGF)	Removes BOD and nutrients through aerobic process
5	Polishing Pond	Collects effluent from PGF for further reduction of BOD and bacteria. Water from the pond is utilized for landscaping and plantation inside SeTP
6	Sludge Drying Bed	Used for dewatering and drying of sludge
7	Sludge Storage Yard	Collects and stores sludge from drying bed for composting/disposal

CITY PURI

Puri is in the coastal delta of the Mahanadi River on the shores of the Bay of Bengal. According to the 2011 Census of India, Puri is an urban agglomeration governed by the Municipal Corporation in Odisha state, with a population of 201,026.Puri is first among the AMRUT towns to have a SeTP completed in October 2017. The plant in Puri employs Co-Treatment for Septage management. The solid present in the septage are separated in a setting- cum –thickener tank, which is then taken to the sludge drying bed for drying and disposal. The liquid part of the septage is treated in the STP located adjacent to the SeTP. The holy town of Puri is the first in Odisha to have a Sewerage and Septage Management Project. While in the first phase, a sewerage infrastructure has been developed to cater 18,400 properties, majority of the population still depends on the on –site sanitation practices. Orissa Water Supply & Sewerage Board (OWSSB) has constructed a 50 MLD capacity Septage Treatment Plant (SeTP) at Mangalaghat, Puri in October,2017. The SeTP employs co- treatment method for treatment of septage where the liquid faction is treated in a Sewerage Treatment Plant (STP) located adjacent to the SeTP. The Plant was constructed under AMRUT and it uses Co- treatment technology for the treatment technology for the treatment of sludge being unloaded. The Setting –cum-thickener tank of SeTP allows heavier particles of the unloaded septage to settle down to the bottom of tank while the lighter part of septage remains above. The settled sludge get thickened in the settling –cum-thickener tank and removed by pumping at regular interval to the sludge drying bed for removal of moisture content. The leachate from sludge drying bed is collected in a leachate sump which is pumped to the pre – treatment unit of sewerage Treatment Plant (STP) which is co-located with the Septage Treatment Plant (SeTP) for further treatment and disposal.

Treatment Technology : Solid liquid separation, liquid fraction co-treated in STP & Solid fraction dewatered in sludge drying bed for further use.



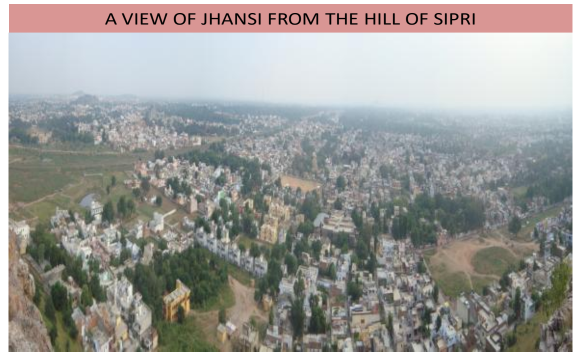
FAECAL SLUDGE TREATMENT TECHNOLOGY IN PURI	
Techn	Co-treatment in STP – Biological
Working Principle	This is a treatment of Faecal sludge and septage in Sewage Treatment Plant (STP) with pre-treatment facilities for Faecal sludge.
Key features	• Due to the similarity of the characteristics of the sewage and Faecal sludge co- treatment is considered option • The two options for treating Faecal sludge in STP. It could be treated either as part of liquid stream or sludge handling stream • Addition to either of the stream pretreatment infrastructure in the STP and distribute the sludge into appropriated treatment unit in STP • For addition to liquid stream in STP, Faecal sludge be added at multiple treatment points viz., screening, before primary treatment (primary clarifier) or before secondary treatment (ASP) • Faecal sludge addition to sludge stream may be made either at before sludge stabilization or dewatering stage. • For co-treatment STP need to be equipped with Faecal receiving station, pre-treatment facilities and redistribution facilities in STP • The influent quality requirements for the STP at both liquid and solids addition points must be met during the additions

Performance	With pretreatment facilities and STP capability to handle Faecal sludge, prescribed sewage treatment norms be met. The sludge handling system should have pathogens inactivation/
Applic	Faecal sludge and sewage
Operations & Maintenance	• Regular cleaning of pretreatment facilities • Monitoring the pretreated Faecal sludge to match to the STP requirements
Strengths	• Faecal sludge and sewage be treated at single location minimizing the maintenance requirements • No separate infrastructure required for Faecal sludge
Challenges	• The Regulated flow to the STP needs to be engineered and changes to this can effect the entire performance of the STP • STP capability to handle Faecal sludge is governed by (i) quantity of Faecal sludge and (ii) aeration capacity and solids handling capacity of the plant • The ability of the STP to co-treat Faecal sludge depend on STP type, design capacity and Faecal sludge pretreatment facilities as Faecal sludge is 50 times higher strength than sewage

Technology Installed Location Details		
Location (s)	Status	Technology Provider
Puri, Orissa	Operational. Commissioned in 2017	--
Capacity	Area Requirement	Manpower
50KLD	20 sq.m./KLD	Not available
	Primarily adopting to existing STP; civil works ranges from 45 days to 60 days	
Capital cost and Operational cost	Capital cost: Rs 3.5 lacs/KLD Annual Operating Cost: Rs. 35000/KLD	

CITY JHANSI

A VIEW OF JHANSI FROM THE HILL OF SIPRI

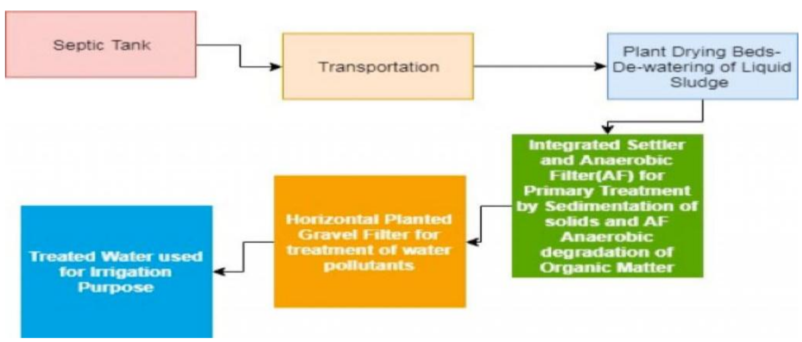


Jhansi is a historic city in the Indian state of Uttar Pradesh. It lies in the region of Bundelkhand on the banks of the Pahuj River, in the extreme south of Uttar Pradesh. Jhansi is the administrative headquarters of Jhansi district and Jhansi division. Also called the Gateway to Bundelkhand, Jhansi is situated between the rivers Pahuj and Betwa at an average elevation of 285 metres (935 feet). It is about 415 kilometres from New Delhi and 99 kilometres south of Gwalior. According to the 2011 census, Jhansi has a population of 1,998,603, its urban agglomeration a population of 547,638 and Jhansi Municipal

Corporation is Designed Fecal Sludge treatment unit for 6 cum capacity and planted sludge drying beds are structure with sloped based for holding graded filter media. The sludge undergoes liquid-solid separation and also drying. The dried sludge from the planted drying beds are removed one in 1 or 2 years depending on rate of feeding and the rest of the part which is the liquid percolated or effluent wastewater is conveyed to the seprate treatment units. The effluent wastewater is then treated in two stages primary and secondary in DEWATS module. Jhasi Municipal Corporation established Faecal Sludge Treatment Plant near the Bijoli Industrial Area in Jhansi, Uttar Pradesh. The Bijoli FSTP at the periphery of city from where Madhya Pradesh starts.

Need for technology

To provide sanitation service within the service area in the form of Feacal management system in the most cost effective, healthy work environment and environmentally responsive method.



System Description:

1. Plant dying beds (PDBs): Applying to the planted dying beds which are loaded with layers of sludge to get dewatered and stabilized through multiple biological and physical mechanisms.
2. Integrated Settler and Anaerobic Filter(AF): The percolate from PDBs is subjected to treatment in the integrated settler and anaerobic filter (AF) in which settler is a primary technology for wastewater and AF consists three chambers in which pipes enable water to reach at tank's bottom where the suspended solids undergo anaerobic degradation.
3. Horizontal Planted Gravel Filter: It's a tertiary treatment unit where the pollutants are degraded aerobically. HPGF is made up from planted filter materials consisting graded gravel bed and it's necessary to remove the odour and colour to enrich WW with oxygen.
4. Stabilization Reactor: Its objective is to allow the sludge to digest anaerobically which leads to reduction in organic load and better the dewater ability.

5. Sludge Dying Beds: It has permeable bed filled with several drainage layers. It percolated leachate and allows the sludge to dry by percolation and evaporation.
6. Settler: This is a rectangular tank in which faecal sludge is discharged into an inlet at the top of one side and the effluent leaves through an outlet on the opposite site and solid settles at bottom of the tank.
7. Anaerobic Filter: It is used for secondary treatment for pre-treated wastewater upon the filter area.
8. Vertical Planted Gravel Filter: This technology is appropriate where trained mechanical staff, constant power supply and spare parts are available. A vertical flow constructed wetland is a planted filter bed for secondary and tertiary treatment.

COMPARATIVE STUDY OF FSSM PLANTS				
Parameters	NAME OF THE CITIES			
	Bhubaneswar	Jhansi	Puri	Wai
Scale of service	City Level	City Level	City Level	City Level
Inlet	Faecal Sludge	Faecal Sludge	Faecal Sludge	Faecal Sludge
Year Of Construction	2017	2018	2017	2018
Area of Installation	2.47 acres	1 acres	0.48 acres	0.23 acres
Capital Investment	3.54 Cr	2.1 Cr	1.76 Cr	5.6 Cr
Funding Source	AMRUT	AMRUT	AMRUT	Bill & Melinda Gates Foundation
Designed Capacity	75 KLD Expandable 150 KLD	6 KLD	50 KLD	70 KLD
Number of Users/ People Affected	2,20,000	1,OO,OOO	44,187	36,025
Operation and Maintenance cost Per Year	0.193 Cr	0.276 Cr	0.169 Cr	0.065- 0.1 Cr
Construction Operation and Maintenance Responsibility	Orrisa Water Supply and Sewerage Board	Private Operator	Orrisa Water Supply and Sewerage Board	TIDE Technocrats, Bangalore, Karnataka
Technology	Solid Liquid Serration followed by treatment of liquid by DEWATS	Solid Liquid Serration followed by treatment of liquid by DEWATS	Solid Liquid Separation followed by treatment of liquid IN STP collocated	Paralysis – Non-Biological
Number of vehicle /Cesspool	4	3	4+ 2 Already	by Private Operator
Capacity of Vehicle	3000 L	11500 L	3000 L	
Solar Plant	10 KW	½ HP Solar Pump	-	-

Learning from above Case Studies:-

- Understand how septage and waste water treatment technologies works, what level of treatment do they achieve and what are the pros and cons of each.
- Gain familiarity with technology options available in the market.
- Decentralized faecal septage treatment plants are emerging as solutions to the challenge of addressing safe treatment and disposal of septage. However it does not imply that all small towns and cities need FSTPs infrastructure for safe treatment and use of septage waste and waste water needs to be promoted for smaller towns that do not generate large volumes of septage requiring centerlised sewerage system.
- A solar plant of 10 KW capacities has been installed and made operational in Bhubnaeswar , which is an on-grid system. The surplus power can generate revenue for the plant and same should be replicated in every city
- Co–treatment of septage with STPs should be the first option in terms of cost, land resources and operative finances in place.
- The ideal discentralized sewerage system sholud have the following consideration Simple to construct, operate and maintain ;Least cost with respect to electrical energy consumption;Highly efficient under adverse environmental conditions;Least cost with respect to Capex and Opex;Effective in utilizing liquid by-product;Provide scope for further research and development;Most of the construction material locally available

Way forward:-

- No single technology is better than the other, on all considerations and parameters. Hence the choice has to be made by cities as to the preferred septage and waste water treatment technology options available in the market.
- The untreated human waste what we call faecal sludge needs to be treated. Be it household level or institutional level, it needs to be treated and an appropriate system needs to be in place if we want healthy life and healthy community.
- Decentralized FSM can be a good demonstration plant on these public utilities and possibility to introduce FSM in newly developing areas, public institutions like schools, universities, hospitals,

apartment etc is something which needs to be addressed by planning bodies. A conductive environment for private sector and the promotion of PPP model in FSM will create more scope for funding opportunity for infrastructural development. Onsite sanitation solutions seemed necessary to disseminate with sanitation stakeholders for their possible promotion.

- ULBs at present are investing neglageble amount in changing public behaviour and awareness building. It's only when some NGOs/CSOs are involved that awareness building is being done. This needs to be looked into seriously and awareness drive has to be a regular component in all programmes. ULBs need to engage more NGOs, Theatre Groups, Celebrities and other possible people and institutions to build continuous awareness.
- There are many gaps and lacunae in the data available at the ULB level with regard to solid waste and liquid waste generation, disposal and treatment. The ULBs should immediately equip their MIS facilities with better computerization and coordination for pooling all data from all sources and make them available to the planners as well as other stakeholders in a single window facility. Universal access of data is needed to get a clear and updated picture of the waste management of the cities for all stakeholders to be able to gauge the current scenario and plan towards effective participation in the efforts of the ULBs. There is an urgent need for technological integration through GPS enabled transportation system to work towards making this more transparent for effective management of the wastes.
- The surface water bodies and low lying lands such as floodplains in cities need to be made pollution free. At the moment they bear the maximum brunt of open defecation and wastewater from the cities. Overall, a River Conservation Plan needs to be worked out by all cities situated along the river.
- The following policy points should be keept in consideration in view off mitigating water poluttion and conservetion of water bodies building regulation with respect to design of septic tanks, inspection and retrofitting existing non-standard installations, strict apartment inspection and penalization regular inspection of on-site system, building up database to establish desludging requirements; more emphasis on research related aspects for proper utilization of end product of Faecal Sludge; Life cycle of Faecal Sludge should be maintained like collection, treatment, scientific disposal and use of end product.
- In view off optimum uttilization of land resourcee, avability of compostable waste and transport conveninvce, FSTP plant may be stablised in the adjoining Solid Waste dumping ground/ landfill sides.

In this way compost from solid waste and end product of FSTP may be mixed for converting good organic manure

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