WELCOME

To

A Presentation

On

Mainstreaming Citywide Sanitation

Opportunities & Challenges for Excreta Management

With Focus On

“Bio Digester”

Two Major Challenges of India

Sanitation:

- India is The open defecation capital of the world.
- 50% of population not having proper sanitation facility.
- Other 50% cause severe fresh water wastage & pollution.

Water & wastewater:

- Many states and towns are reeling under severe water shortage
- roughly 80% of fresh water that reaches households leaves as waste.
- Distance from source to consumption point of fresh water is increasing alarmingly.
- complete disconnect between water supply and sewage management.

Drowning India in its own excreta (CSE)

Current Urban Landscape

- Majority of colonies & population have no sewer connections.
- STP capacities and conditions are inadequate for meeting the treatment requirements.
- High open defecation,
- Improper construction and management of septic tanks and leach pits,
- Unhygienic emptying, transportation & treatment of faecal sludge,
- Resultant poor quality of water bodies and ground water aquifers.

Way Forward → Holistic Solution

Holistic solution: A Joint solution by town planners, engineers and social entrepreneurs using environment friendly, economical and self sustainable solutions:

- Identifying all the factors of concern,
- Studying various available & emerging solutions,
- Identifying holistic yet location specific solutions,
- Implement comprehensive, appropriate & effective solutions.
- Review & monitor effectiveness

Proposed Approach

Address following key concern areas for hygienic Citywide Sanitation -

1. Excreta treatment as source,
2. Safe Conveyance /transportation of untreated/partially treated sewage to a local treatment centres,
3. Decentralized treatment of sewage and septage.

Comprehensive Improvement Plan

1. **Excreta Treatment at source**:
   - Provide safe community toilets with bio digesters where space available.
   - Provide co-owned toilets with bio digesters where people can afford.
   - Provide bio digesters in existing community toilets for safe management of sewage.
   - **Conversion of insanitary toilets into bio toilets** :
     - Provide bio digesters in place of twin pits/dry pits.
     - Convert existing septic tanks into bio digesters.

Comprehensive Improvement plan

2. **Safe Conveyance /transportation of partially treated sewage & decentralized treatment:**

a) Provision of covered drainage system for conveyance of bio digester treated sewage and household grey water drainage to a common , street-end digesters.

3. **Provision of street-end digesters/decentralized FSMS to treat brown water (mix of treated black water & untreated grey water).**

a) Provide secondary treatments where necessary & feasible.

b) Provide operation and maintenance services for pre-agreed period with MC for ensuring SLA.

Key Challenges

1. Locational
2. Historical
3. Topographical
4. Technological
5. Behavioral

Proposed Solutions

The proposed solutions will cover:

- **individual household sewage management.**
- **Small public toilet complexes.**
- **Centralized Bio digester based sewage treatment plant.**
- **Trailer mounted modular FSM system**
- **Operation, Maintenance & monitoring of the entire system in real time.**

Technologies employed in Proposed Solutions

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Technologies employed in the proposed solutions are:

- Bio digester technology based on accelerated & assisted anaerobic decomposition of waste.
- Anoxic treatment for nutrient removal.
- Natural/Assisted Aerobic treatment.
- Vertical/horizontal flow constructed wetland treatment.
- Bio sand treatment.
- Modular combinations of above technologies.

Bio-digester Technology

- A consortium of specially developed bacteria called Anaerobic Microbial Inoculum (AMI) converts bio-waste into bio-gas and safe water.
- A specially engineered container called the bio-digester ensures effective treatment of bio-waste.
- Waste decomposition takes place in stages of electrolysis, acidogenesis, acetogenesis & methanogenesis processes.
- The process is self sustainable with minimal scheduled maintenance.
- The process is anaerobic hence there is no foul smell and over 99% deactivation of disease causing pathogens.

The Bio digester technology has been developed by DRDO & further improved by licensees

Secondary treatment Technologies

- Primary anaerobic treatment reduces the sewage significantly.
- A series/combination of secondary treatments converts this pre treated waste water into re-usable water.
- Based on influent quality & quantity, the end products are – usable water, bio-gas, bio-fertilizer.
- The secondary processes are also low on energy requirements & sustainable with minimal scheduled maintenance.

Water Quality

- **Left side: untreated sewage.**
- **2nd : Partial treatment in bio digester, free of solid waste.**
- **3rd : properly treated in bio digester : good for agriculture and arboriculture.**
- **4th : CWL treated with natural aerobic treatment: good for recycling, flushing, cleaning, even discharge into rivers (meeting all STP discharge norms).**

Treated Water Quality

Parameters	Septic Tank	Bio digester	B Digester & CWL
pH	6.0-7.5	6.5-7.5	6.5-7.5
Turbidity (NTU)	500-800	70-90	2-5
TSS (mg/L)	150-300	90-120	20-40
TDS(mg/L)	500-850	350-450	100-300
VS (mg/100ml)	50-60	20-30	5-12
COD (mg/L)	300-400	150-200	40-50
BOD 5 (mg/L)	150-200	50-70	10-20
Coliforms (MPN/ml)	>3000	200-350	0-15

Septic tank Vs. Bio Digester

Sl	Characteristic	Septic tank	Bio Digester
1	Nature	Anaerobic/facultative	Anaerobic
2	Human waste decomposition	Minimal decomposition approximately 40%	>90% decomposition
3	Air pollution	Foul smelling H_2S	natural methane and CO_2
4	Water pollution	high pollution	minimally polluting
5	Pathogen reduction	low	over 99% disease bearing pathogens are inactivated
6	Space requirement	Requires higher space	Requires 50% or less
7	Size of Tank for 20 & 300 persons	4.55 cum. for 20 persons & 75 cum. For 300 persons as per IS:2470	2.00 cum. For 20 persons & 25 cum. For 300 Persons as per DRDO

Septic tank Vs. Bio Digester

Sl	Characteristic	Septic tank	Bio Digester
8	Treatment Parameters	BOD – 150 mg/l TSS – 300 mg/l	BOD ~ 50 mg/l TSS ~50 mg/l
9	Construction Cost	2 times higher than Bio – Digester due to size of Tank	50% less cost
10	Sludge Generation	Very High & parameters are harmful for environment.	Very Low & parameters are not high as such biological process.
11	Quality of output Water	Decreases with time	Always same
12	Operation and maintenance	Requires evacuation after 2 years according to given size. As per IS: 2470, table 6	Requires evacuation after 5 years or more according to given size.
13	Application of output water	Not useable without Secondary Treatment.	Output parameters match with the parameters given by CPHEEO for gardening.

Typical Faecal Sludge (discharge from septic tanks)

Criteria	Parameters	Units	Results (FS)	Results (SS)	Remarks
Organics	Chemical oxygen demand	Mg/l	35000-40000	1000	Very high load
	Biological Oxygen demand for 03 days at 27^0C	Mg/l	10000-15000	300	Very high load
Physical	pH	Unit less	6.5-7.5	6.5-7.5	Same
	Turbidity	NTU	500-700	200-300	High
Bacteria	Coliform MPN	CFU/100 ml	$(2\text{-}6)X10^4$	500-700	Very high

Practical Deficiencies

- The people trying to shortcut & made the single chamber in septic tank.
- Sock pit is not available.
- Criteria given in CPHEEO manual not followed.
- Leaching water proofing does not used which causes smell & leakage.
- Soap water, Acid & chemicals used into toilets which are very harmful.

Land & resources for Bio digesters

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Typically land & resources required for bio digesters is less than that for conventional septage solutions.

1. **Super structure requires the same amount of space as normal toilets.**
2. **Bio digesters require lesser space (30-40%) compared to septic tanks.**
3. **Bio digesters can obviate the need for sewerage which is essential for conventional systems.**
4. **Bio digester based toilet systems does not require any additional operational maintenance, rather it requires less maintenance as it does not need regular evacuation.**

Bio Digesters

Frequently Asked Questions

How much AMI is required to seed a Biodigester for a household of 5 members?	✓ 200 L of AMI is needed for a single family bio digester.
Is AMI available in the form of powder & Pellets?	✓ No. Inoculum is liquid.
Can we use AMI in ETP (Effluent treatment plant)?	✓ AMI is not recommended for ETP
Are there any regulatory guidelines with respect to manufacturing of AMI?	✓ No. But DRDE has GMP guidelines for manufacturing of quality inoculum.
What are simple tests for analysis of AMI's functionality and what changes are expected when it is no longer functional?	✓ It should have pH around neutral range (6.5 - 7.5) when mixed with fresh waste (cattle dung) and kept for 24 hours produces inflammable biogas.
What is (Anaerobic Microbial Inoculum) AMI?	✓ Microbial consortium developed by DRDE, Gwalior is a mixture of different types of bacteria which have been developed by enrichment and acclimatization process.

Frequently Asked Questions

Does bacteria from Biodigester have any effect on human health /environment?	✓ No adverse effect on human health and environment.
What Kind of waste can be used for AMI multiplication?	✓ Any ruminant animal dung can be used like buffalo, Cow, Horse, sheep, goats, and camels.
What is minimum AMI requirement for seeding of Biodigester?	✓ Plain areas – 30 % of working volume ✓ High Altitude Areas – 40 % of working volume.
How can we store AMI?	✓ The inoculum can be stored in bigger tanks. Preferably it should be kept in shaded area, ambient conditions.
What is the shelf life period of AMI?	✓ AMI can remain for a period of 3/6 months, stored in ambient conditions.
How much do they cost?	✓ The cost of Biodigester may vary according to size, material, number of user

Frequently Asked Questions

How much time will it take to install?	✓ It needs to dig a trench (as per Biodigester size) in desired place and placement of biodigester into it.
How often do we have to remove the sludge in Biodigester?	✓ Sludge removal is not needed.
Is a soak pit mandatory or discharge can be permitted in an open channel drain?	✓ Soak pit is not mandatory. The effluent can be discharged into open channel drain.
Does the bottom of tank require a slope from inlet to outlet side for movement of solid waste?	✓ It is not necessary to provide a slope from inlet side to outlet side.
What are the areas in which biodigester toilet can be used?	✓ All geological environments.
Can AMI be used in existing septic tank?	✓ After modification of septic tanks, it can be converted into bio digesters

Frequently Asked Questions

What is the post installation maintenance of Biodigester?	Biodigester does not require any maintenance.
How much time gap is required between installation of Biodigester and its use?	Biodigester can be used immediately after installation and seeding of Biodigester with AMI.
Can Biodigester be used in high water table areas?	Yes.
Can Biodigester be used in coastal areas?	Yes, provided water used for flushing should not be sea water.
if toilet was not used for 2 months, does bacteria recharge required?	No.
whether biogas from single family Biodigester can be used?	No.

DETERGENTS/ ANTISEPTICS TOLERANCE FOR CLEANING

- Phenyl upto 84ppm
- Harpic upto 250ppm
- Domex upto 250ppm
- TASKI R6 upto 250 ppm*
- TASKI Duck fresh upto 250ppm*
- TASKI Clonet W4 upto 100ppm*
- TASKI MM65 upto 100ppm*
- TASKI MM60 upto 250ppm*

* Provided by Indian Railway & manufactured by M/s Johnson Diversy, Mumbai

Why Arkin Creations Pvt Ltd

1. Frontrunners in this technology domain in India.
2. One of the very few in the country to make ***every element (inoculum, bio digesters & toilet shelters)*** in-house.
3. Own team of trained people in producing best quality products.
4. Continuous product development and innovation
5. Expanding application of technology in many fields
6. Complete solution provider.
7. Experienced in installing new digesters, conversion of existing septic tanks, STPs and other applications

PROVIDE HOLISTIC SOLUTION

Proposed approach By Arkin

Arkin's core competency is in the following areas-

Arkin's Seven Pronged Strategy:

1. **Safe sanitation for all,**
2. **Decentralized Waste/waste water treatment systems,**
3. **Water recovery & reuse for farming & gardening,**
4. **Local involvement in solution implementation,**
5. **Skill development & employment generation,**
6. **Review & monitoring system.**

Arkin undertakes total project management

Company Capabilities

Arkin is capable of developing solutions in the fields of operation that are -

1. Modular & scalable,
2. Tailor made for specific conditions & requirements,
3. Integrated to address multiple requirements,
4. Environmentally sustainable,
5. Economical to acquire & operate,
6. Deployable across a wide geographical area.

Full system supplier- Design, engineering, manufacturing, supply, installation, commissioning , service, Operation & maintenance.

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Advantage of anaerobic processes

1. **Less energy requirement as no aeration is needed**

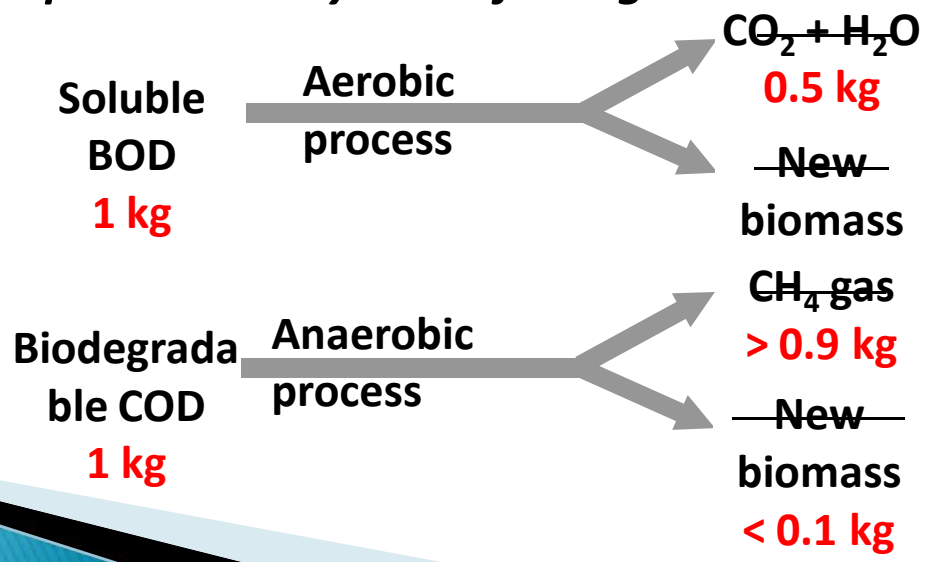
0.5-0.75 kWh energy is needed for every 1 kg of COD removal by aerobic processes

2. **Energy generation in the form of methane gas**

1.16 kWh energy is produced for every 1 kg of COD fermented in anaerobic process

3. **Less biomass (sludge) generation**

Anaerobic process produces only 20% of sludge compared with aerobic process



...Advantages of anaerobic processes

4. **Less nutrients (N & P) required**

Lower biomass synthesis rate also implies less nutrients requirement : 20% of aerobic

5. **Application of higher organic loading rate**

Organic loading rates of 5-10 times higher than that of aerobic processes are possible

6. **Space saving**

Higher loading rates require smaller reactor volumes thereby saving on disposal cost

7. **Ability to transform several hazardous solvents** ***including chloroform, trichloroethylene and trichloroethane to an easily degradable form***

Limitations of anaerobic processes

1. **Long start-up time**

Because of lower biomass synthesis rate, it requires a longer start-up time to attain a biomass concentration

2. **Long recovery time**

If an anaerobic system is subjected to disturbances either due to biomass wash-out, toxic substances or shock loading, it may take longer time for the system to return to normal operating conditions

3. **More susceptible to changes in environmental conditions**

Anaerobic microorganisms especially methanogens are prone to changes in conditions such as temperature, pH, redox potential, etc.

- ***Complete anaerobic degradation of 1 kg COD produces 0.35 m^3 CH_4 at STP***

- ***COD of pure night soil 100 – 150 g O2/ Kg***

- ***Night Soil per person – 300 – 400 g based on food habit***

Study on Bacterial Consortium

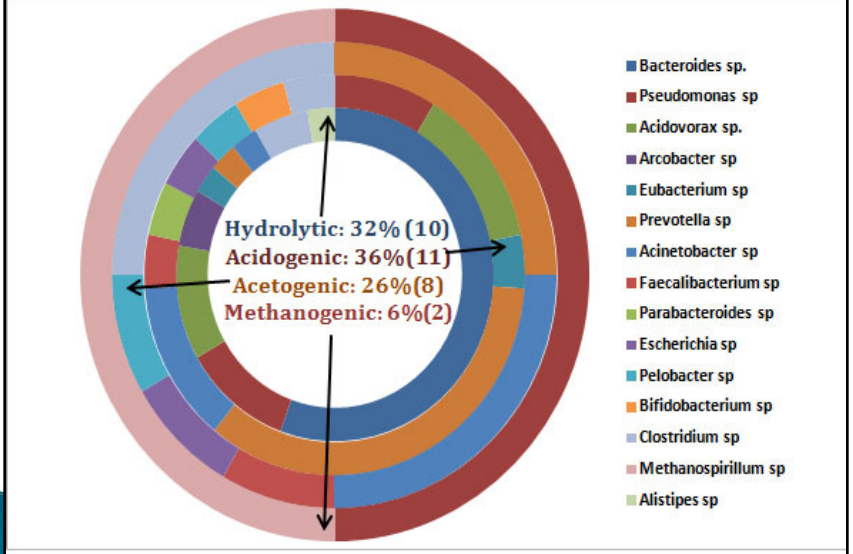
AIM: **#Characterization of anaerobic bacteria in the consortium**
#Required to know the functioning of the system
#Mandatory for the quality control

STUDY PLAN: Parallel Sequencing of Total DNA; Illumina GAIIX platform used
•Quality control, clustering and similarity-based annotation & prediction done
•Out of 17882386 reads, species and proteins were predicted using latest database servers

Four Functional Groups Identified:

Hydrolytic (eg. *Bacteroides vulgates, B. fragilis*), **Acidogenic** (eg. *Prevotella copri, Acinetobacter sp.*)
Acetogenic (eg. *Clostridium saccharolyticum*) , **Methanogenic** (eg. *Methanobacterium bryantii*)

Distribution of Bacteria (in top 50) according to Gross Function



ALPHA DIVERSITY: Clostridium (81)> Bacteroides (68)> Pseudomonas (68)> Acinetobacter (49)> Prevotella (48)> Eubacterium (25)> Acidovorax (23)> Escherichia (21)> Arcobacter (20)> Bifidobacterium (20)> Pelobacter (5)> Parabacteroides (5)> Alistipes (4) > Methanospirillum (3)

Diversity of bacterial end users in the system:

- Play a crucial role in generating methane & CO_2
- Utilization of H_2, Fatty acids, formates, acetates