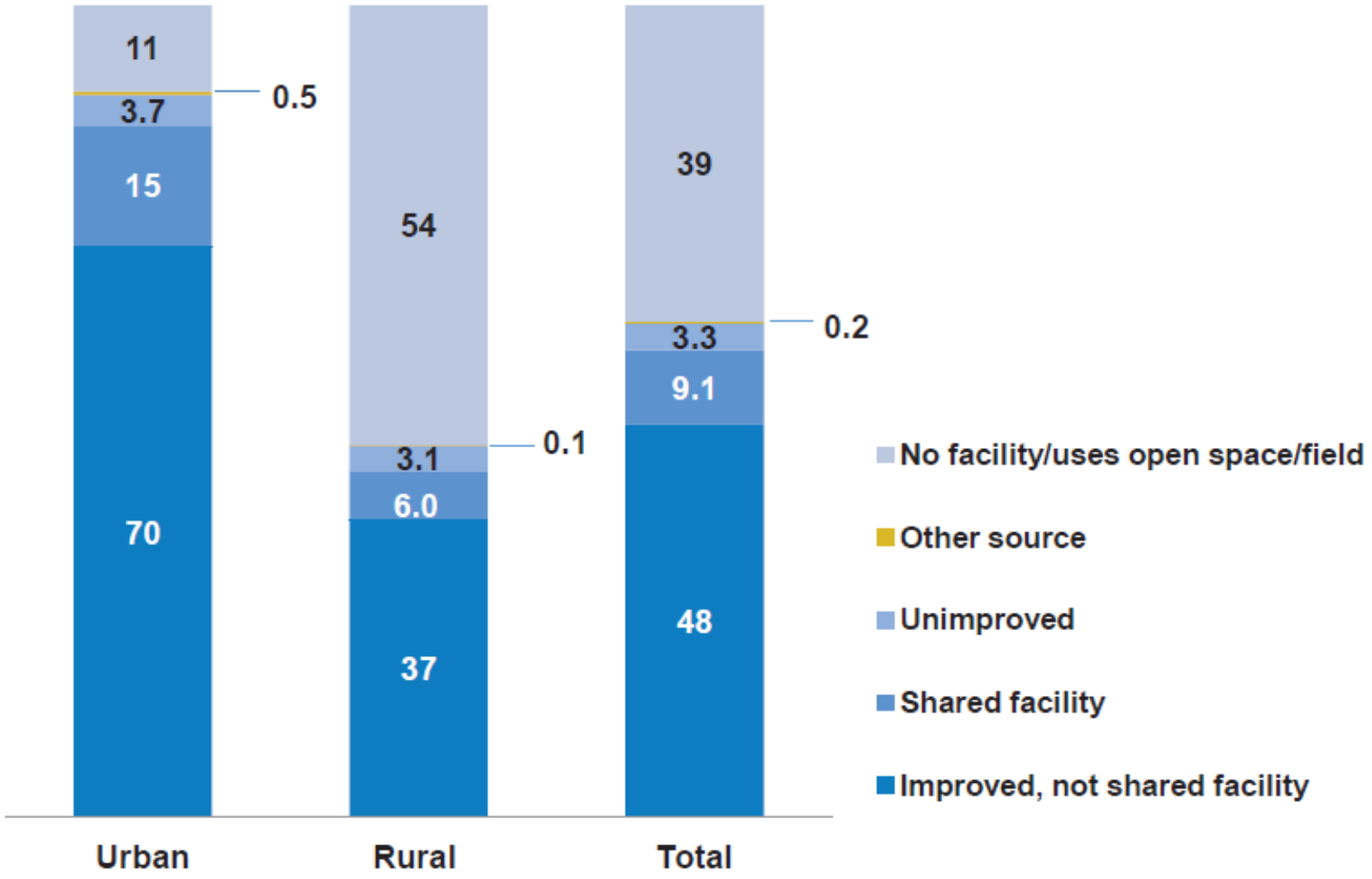
On-Site Human Waste Management Systems in India

Devakanta Pahad Singh
Director PM & SQR (LS)
Defence Research & Development Organization (DRDO)
DRDO Bhawan, Rajaji Marg
Delhi 110011

Sanitation fact sheet

Percent distribution of households by type of toilet facilities



Sanitation fact sheet

- 48% of the households use improved sanitation facilities
- 9% use shared sanitation facilities
- 39% practice open defecation
- Data courtesy – National Family Health Survey 2015-16
- Open defecation reduced from 55% to 39% in a decade
- Improved Toilet Facility:

  includes non shared systems of the following types-

  Dry pit, twin pit, septic tank, bio toilet, pour flush to sewered systems
- Sewer system coverage ≈ 15%

Swachh Bharat Mission

Swachh Bharat Mission (SBM)

- Eliminate open defecation
- Eradicate manual scavenging

SBM (U) – Urban

Ministry – MoUA

Target – construction of 66 lakh toilets in urban slums by 02 Oct 2019

Status – 46,80,000 already constructed

SBM (G) – Gramin

Ministry – MDWS

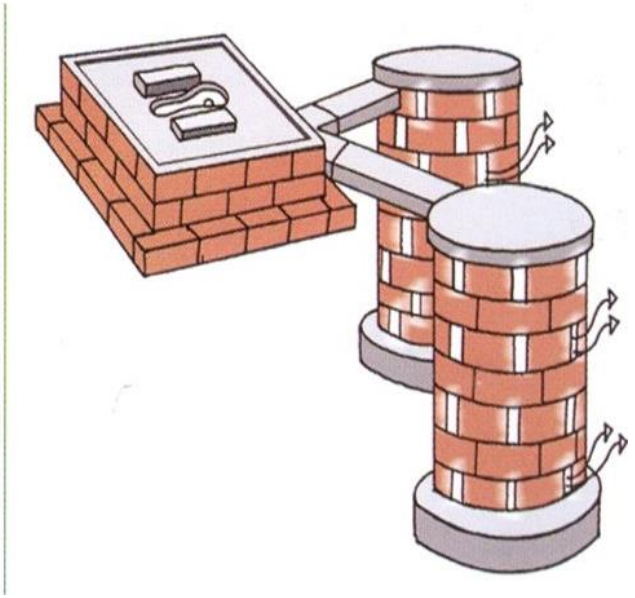
Target – 100% coverage by 02 Oct 2019 (approx. 8.55 Cr)

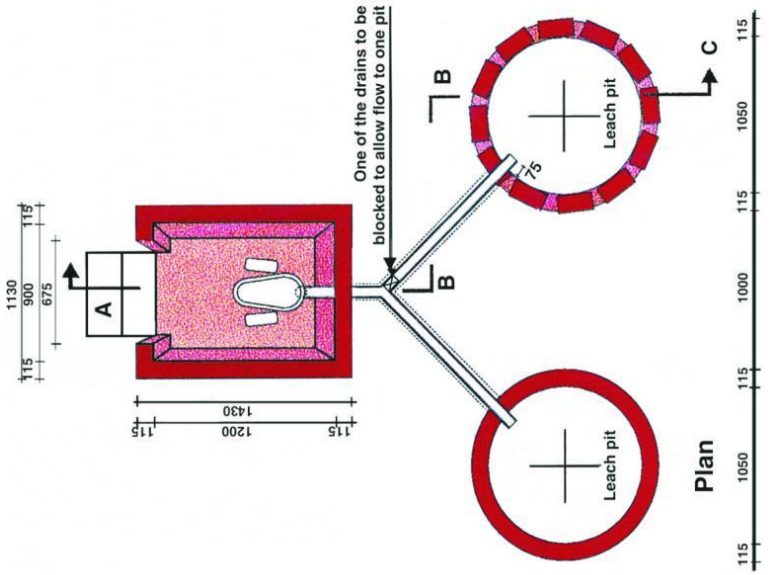
Status – 7,55,00,000 already constructed

Market size:

8,00,00,000 Bio toilets at Rs 12000 = Rs. 96 thousand crores

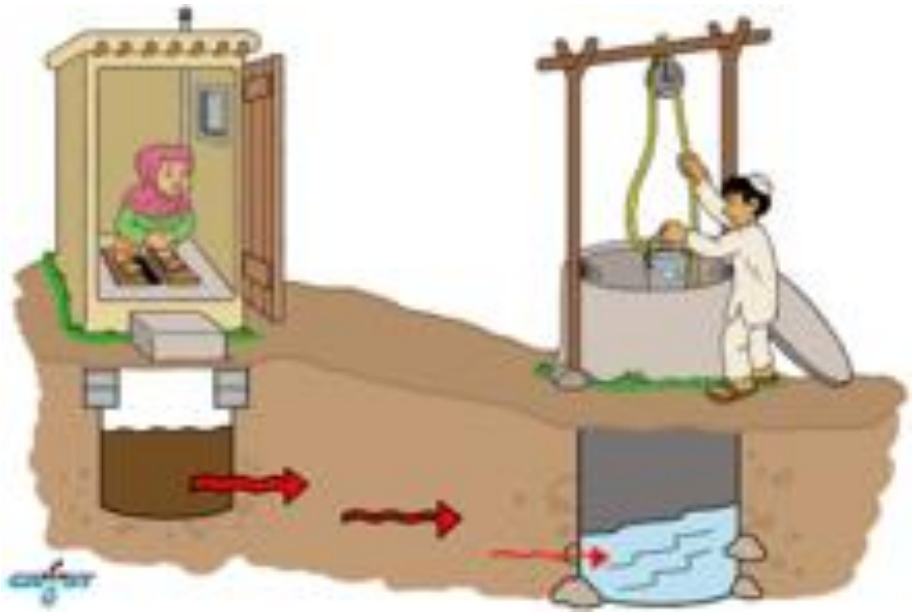
Twin Pit Toilets





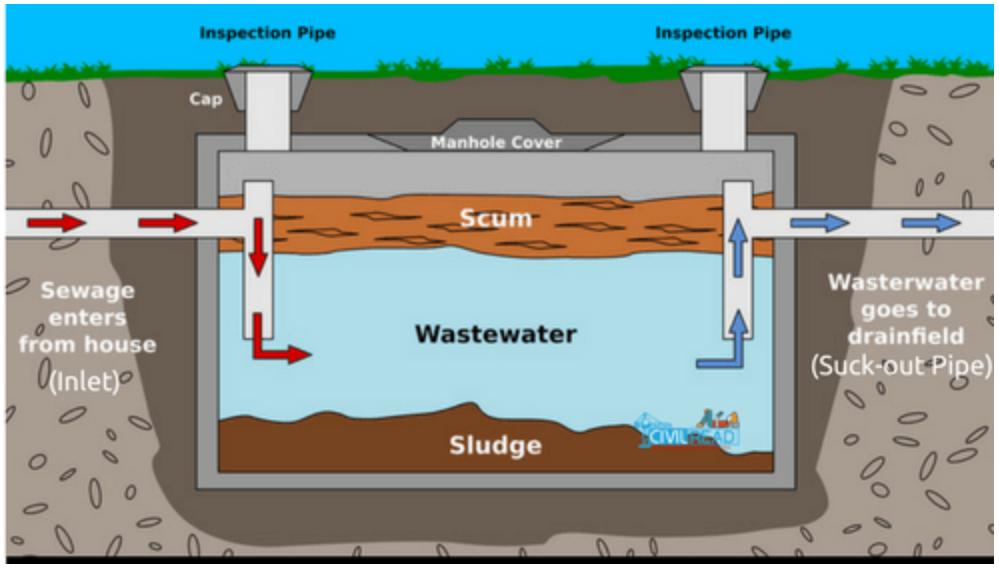
- Flagship technology for Swachh Bharat Mission
- Cheapest option
- Based on Sulabh twin pit design
- Variations are made locally

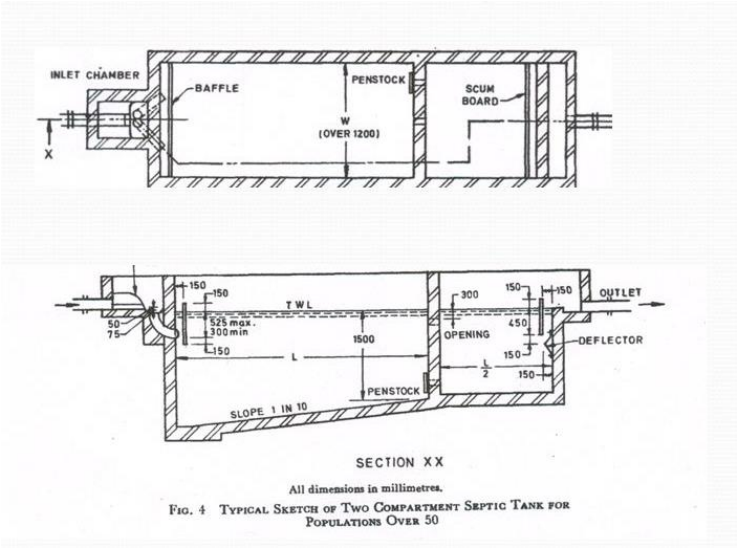
Twin Pit – issues and long term effects



- Not suitable for high water table/ coastal areas
- Not suitable for rocky areas
- Leads to water table contamination
- Pathogen can survive and get reactivated in dry waste

Septic Tank





- Suitable for high water table areas also
- Septage evacuation and disposal an issue
- Lower treatment efficiency
- H_2S formation, harmful and corroosive

Human Waste Treatment Challenges

Wide ambient temperature:
-50° C to 50° C

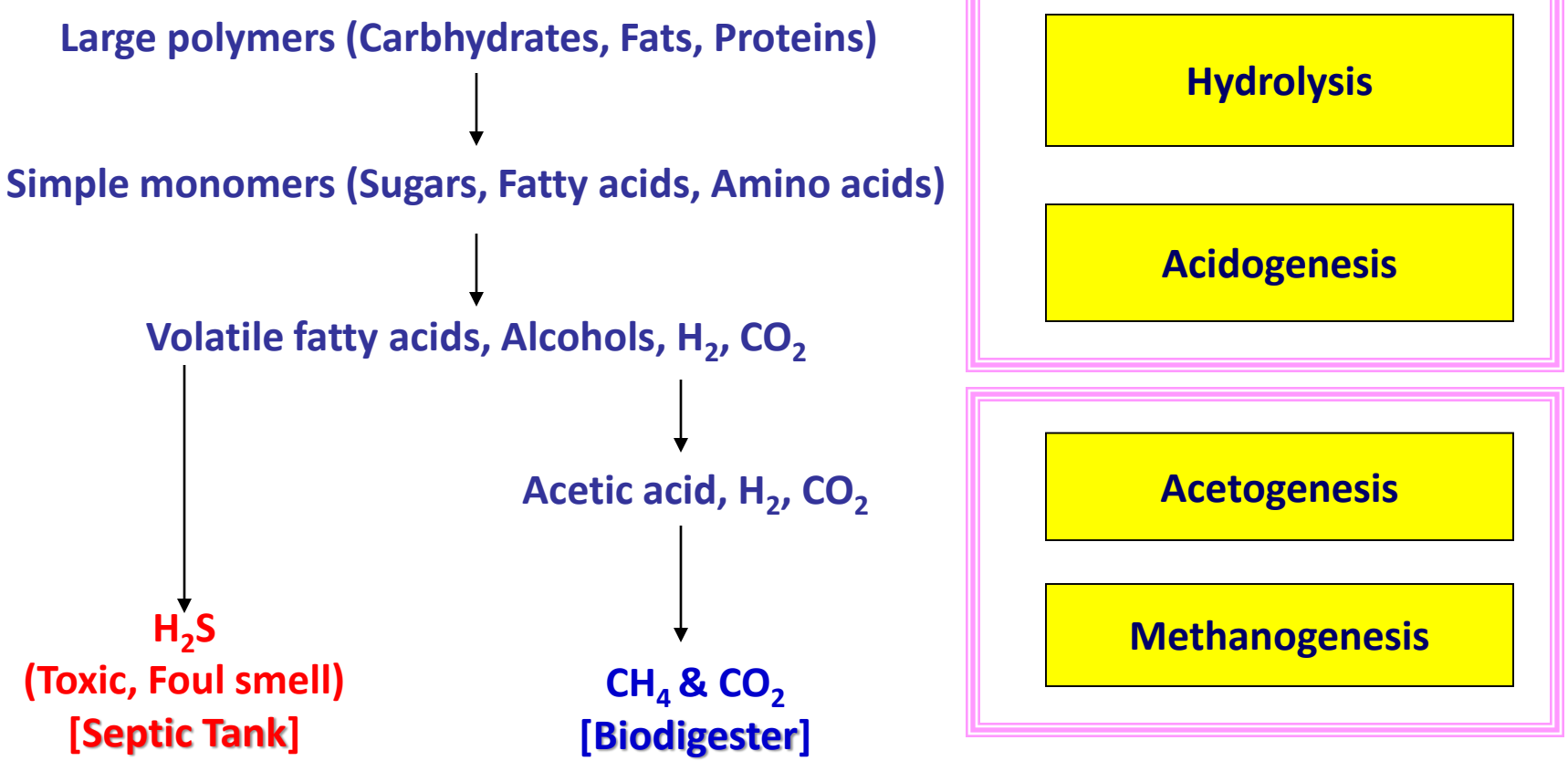
Variety Of Terrain:
High altitude, Hilly,
Marshy, Plains, Desert, Coastal Areas & Islands

Water Conditions:
Low / High Water Table
Dry / Flooded / Water Logged Areas
Fresh/ Saline water

Socio-economic conditions:
Economic Constraints, Awareness
Personal ablution practices

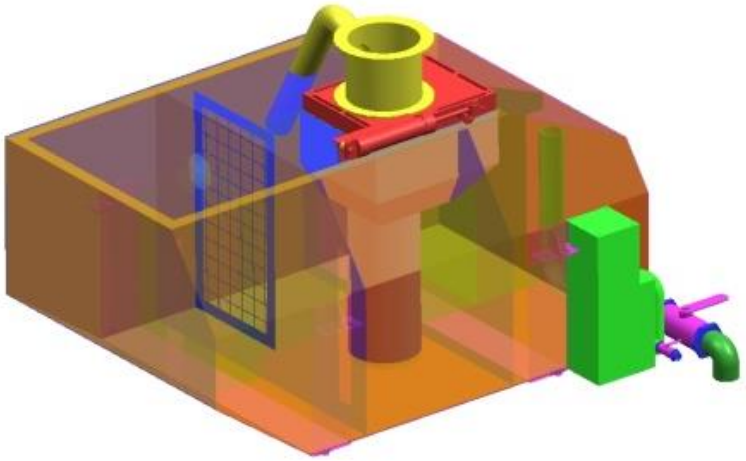
Stationary/ mobile requirements
Floating/ permanent population

Steps in Anaerobic Digestion



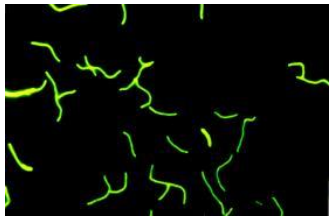
Biodigester

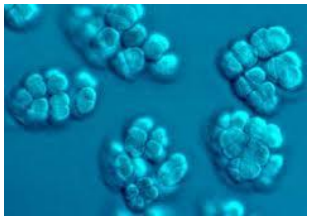
- Device used for accelerated anaerobic microbial degradation of organic waste (human, animal & kitchen waste)
  - Secondary treatment (optional)
    - Chlorination & Reed bed



DRDO Biodigester Technology

BACTERIA (INOCULUM)





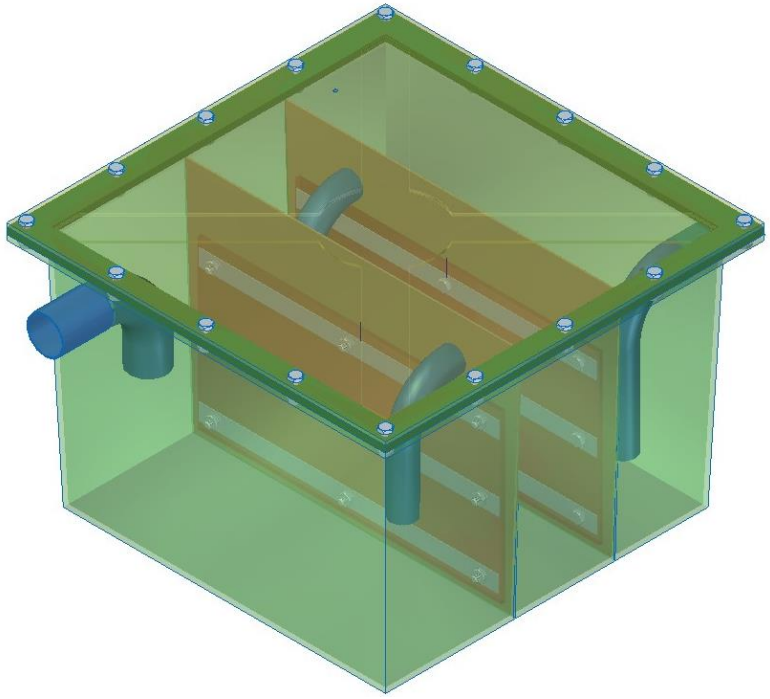
Anaerobic microbial consortium developed by acclimatization/ enrichment of microbes at low temperature and bio-augmentation with critical group of bacteria

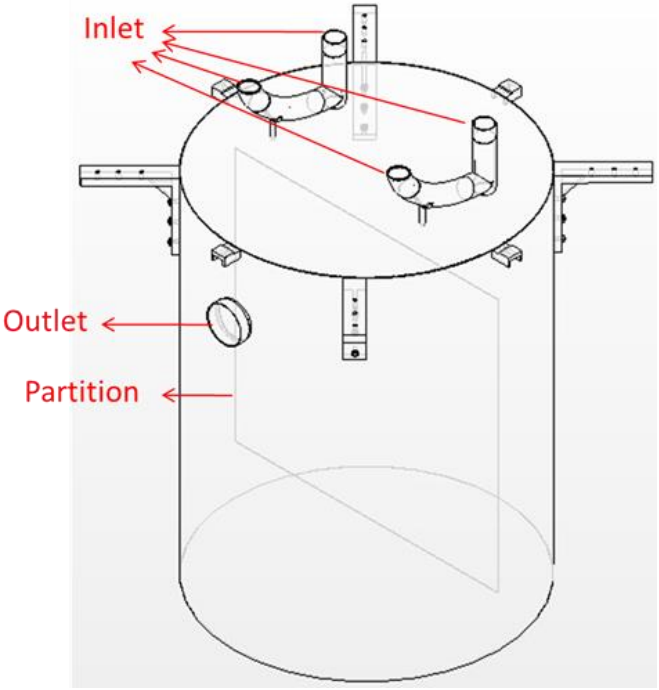
DRDO Biodigester Technology

BIODIGESTER

Fermentation device for accelerated microbial degradation of organic waste

Biodigester is made of mild steel/ SS/ FRP/ bricks Dimensions and internal design vary with no. of users, water availability & geo-climatic conditions





Advantages of Biodigester

- Eco-friendly & cost-effective
- Minimizes water consumption
- Recycling of effluent water
- Customized & easily adaptable
- Wide applicability under different climatic conditions (mobile & stationary)
- **Maintenance free: no cleaning required**
- Generation of odourless and inflammable biogas
- Reduction in organic waste by more than 90%
- More than 99% pathogens reduction
- Tolerant to toilet cleaning agents

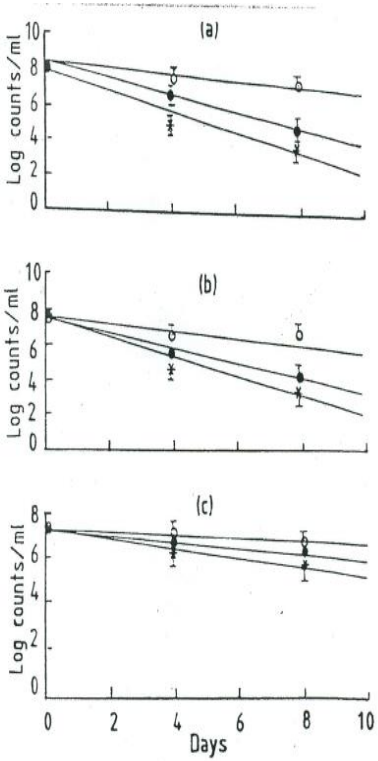


Figure 2. Effect of anaerobic treatment of rabbit waste on pathogen inactivation. a) *E.coli*; b) *S.typhi*; c) *S. aureus*. , 10°C; , 20°C; ,37°C.

Bull. Environ. Contam. Toxicol. (1995) 54:472–478
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Environmental Contamination and Toxicology

Inactivation of Pathogens During Aerobic and Anaerobic Treatments at Low Temperatures

L. Singh, M. Sai Ram, S. I. Alam, V. S. Maurya

Defence R&D Establishment, Tansen Road, Gwalior—474002, India

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Contamination of potable water with human and animal wastes lead to the outbreak of epidemics, such as diarrhoea, dysentery, cholera, typhoid, jaundice etc. There are several contrasting reports about the inactivation of intestinal pathogens during conventional biological waste treatment. Farrah and Bitton (1983) reported that the conventional aerobic and anaerobic waste treatment processes lead to inactivation of pathogens. Findlay (1973), Feachem *et al.* (1978) and Dudley *et al.* (1980) reported that pathogens like *Klebsiella*, *Shigella*, *Salmonella*, *Staphylococcus*, *Pseudomonads* survived anaerobic digestion. In contrast, Carrington *et al.* (1982) showed that *Salmonella duesseldorf* was inactivated in sewage-sludge digesters running at 10 to 20 days hydraulic retention time (HRT). Further, Gadre *et al.* (1986) and Olsen and Larsen (1987) reported that vegetative pathogenic bacteria were inactivated rapidly during mesophilic and thermophilic treatments. Most of these studies focussed on mesophilic and thermophilic temperatures and little attention was paid on the fate of the pathogens during aerobic and anaerobic treatments at psychrophilic temperatures. Since a large part of the earth is in the low temperature zone, the study on survival of pathogens during biological treatment will be useful for the proper disposal of wastes in these regions. Furthermore, the mechanisms of inactivation of pathogens during waste treatment is ill defined.

Non Sewered Sanitation Technologies

Performance:

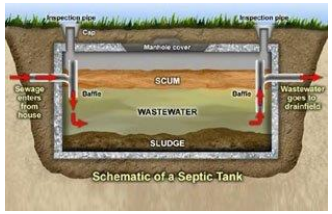
- Waste reduction
- Water recovery
- Energy recovery
- Pathogen reduction
- Effluent quality
- Emission reduction

BMGF
RT
Toilet

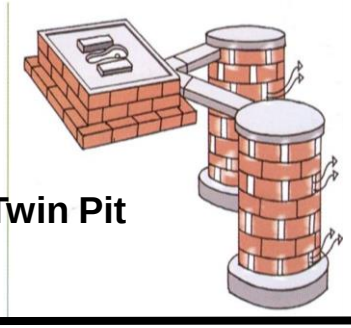
Cost ?

Price

Bio digester



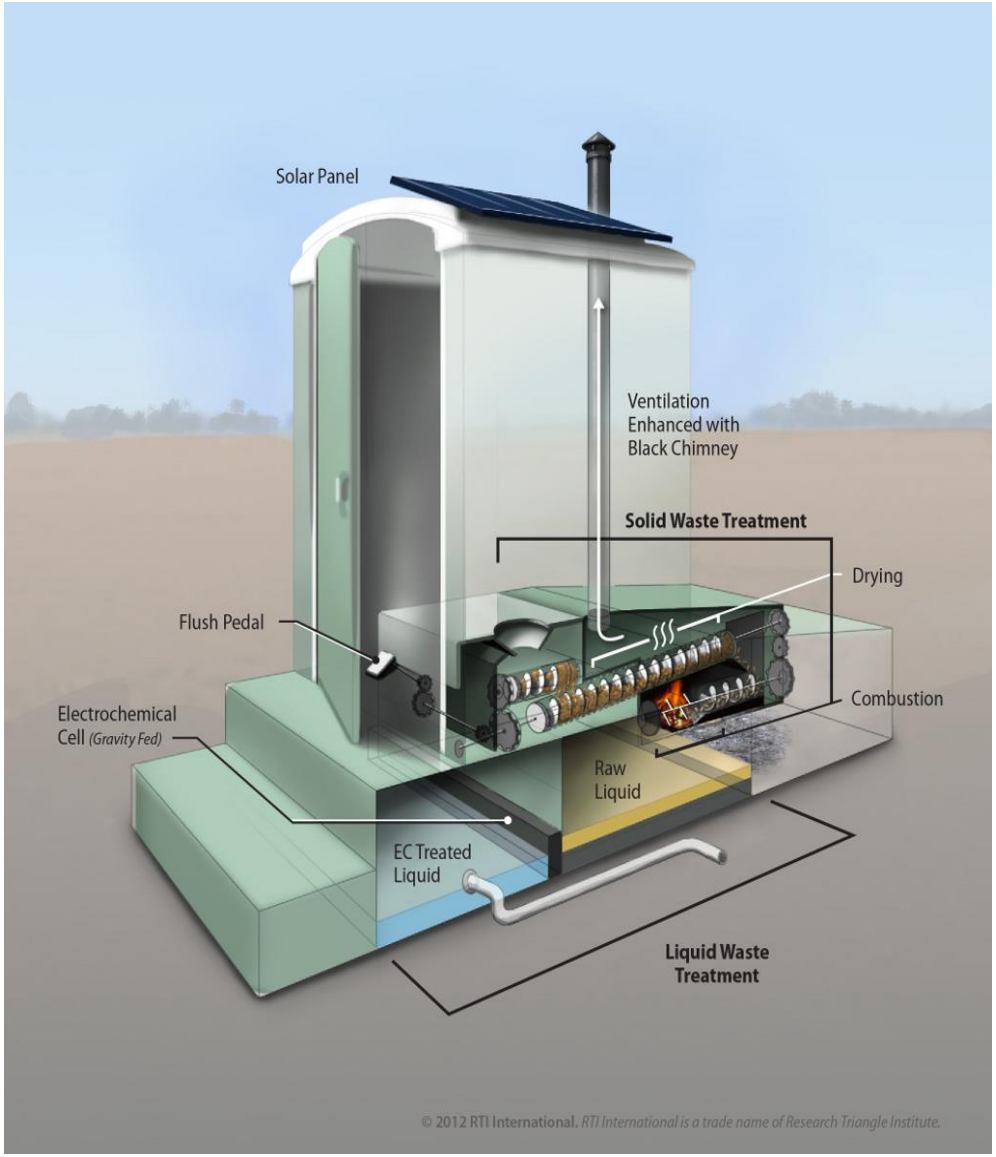
Septic tank



Twin Pit

Performance

RT TOILET - ISO 30500



Reinvent the Toilet – RTI International

- **Initiated by Gates Foundation**
- **ISO 30500 – cleared for publication, Disapproved by India, Germany and Switzerland**
- **MoU with DBT and MoUA**
- **446 projects financed in India**
- **Effluent and Emission**
- **Cost - ???**

Points to Ponder

- Household of 4-6 persons ≈ 4 kg of waste / day
- 4 Kg of waste – energy required for combustion ?

  Amount of energy recovery from a 4 kg waste ?

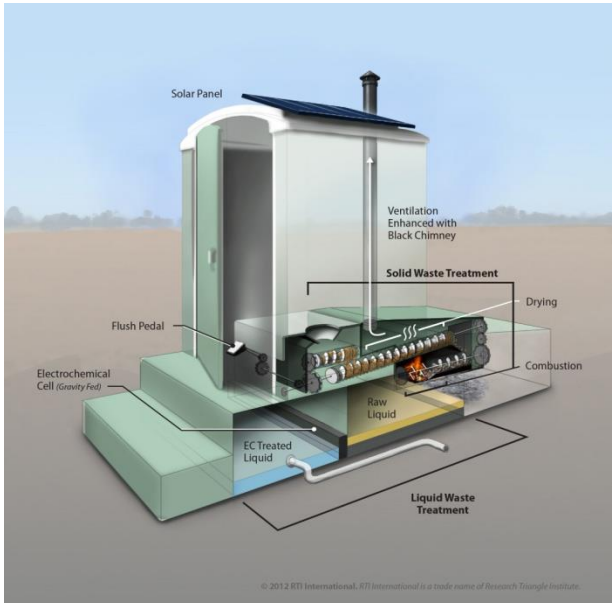
  Energy storage and reuse?

  Amount of water recovery ?

  Energy consumption?
- Cost ???
- Complexity in operation and maintenance
- Water outlet – WHO drinking water quality.
- Gas emission - Air quality standards

Drinking water ?

Options !


Solar Panel
Ventilation Enhanced with Black Chimney
Solid Waste Treatment
Drying
Flush Pedal
Combustion
Electrochemical Cell (Gravity Fed)
Raw Liquid
EC Treated Liquid
Liquid Waste Treatment
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Supercritical Sanitation Systems
Neighborhood-Scale Sewage Treatment
community ablution blocks
holding tank
manual transport
sewage collection vehicles
Sludge
Pressure
Oxygen/Air
Heat
clean water
steam
CO_2
solids (salts)
Duke

Bio digester

Advantages

- Reduces sludge accumulation
- Reduces pathogens
- Engineering design and standardization made
- Maintenance free
- Variants available, flexible installation

Work to be done:

- CPCB certification and approval
- Indian standard, ToT free open standard (Inoculum is controlled)
- New industry partners, with defined minimum production capacity
- Long term – Redesign to match capabilities of RT toilet

..... for better Health & Hygiene

thanks !