



Description of Malaprabha Biogas Plant
Version 1.0, December 15th, 2009

Description of Malaprabha Biogas Plant in Pune District, Maharashtra, India

December 15th, 2009

by Martin Wafler, MSc

on behalf of German Technical Cooperation Agency (GTZ)



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EAWAG Compendium of Sanitation Systems and Technologies:

Description of Malaprabha Biogas Plant is based upon EAWAG technology templates applied in the Compendium of Sanitation Systems and Technologies (downloadable from: http://www.eawag.ch/organisation/abteilungen/sandec/publikationen/publications_sesp/downloads_sesp/compendium_high.pdf)

Malaprabha Biogas Plant

Application Level:

- Household
- Neighbourhood
- City

Management Level:

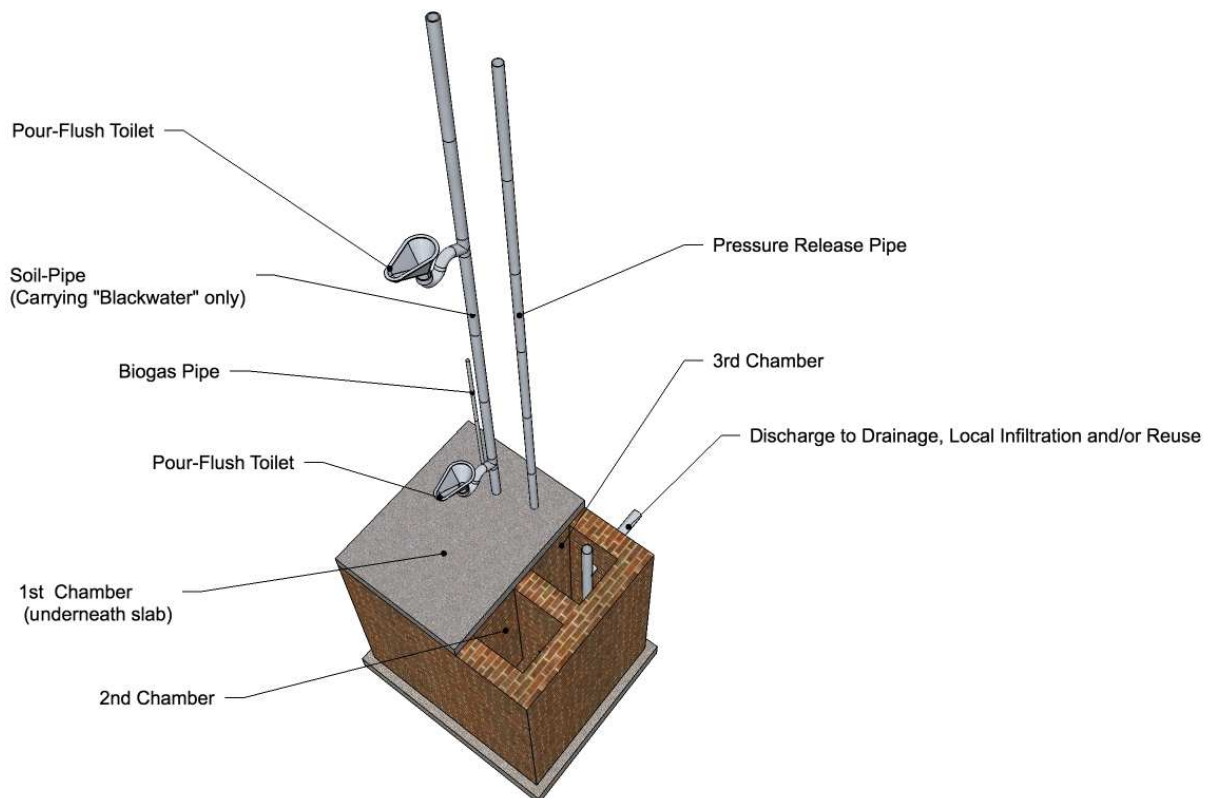
- Household
- Shared
- Public

Inputs:

Blackwater, Anal Cleansing Water

Outputs:

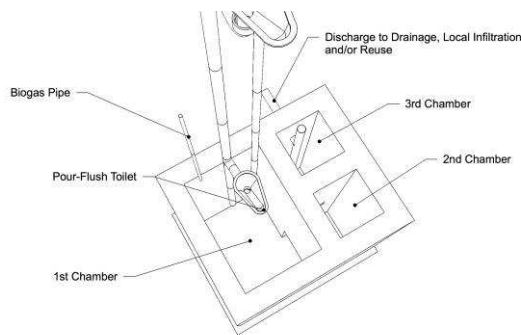
Treated Sludge, Effluent, Biogas



(source: M. Wafler)

figure 1: Perspective sketch of Malaprabha Biogas Plant with attached pour-flush toilets

Malaprabha Biogas Plants are compact fixed-dome type biogas plants that have been developed by Dr S.V. Mapuskar for the treatment of blackwater in densely populated localities with little open space available. Some biogas plants are even installed inside the houses and in many places the toilets are partially constructed on top of the biogas plant itself.



(source: M. Wafler)

figure 2: View of Malaprabha Biogas Plant (without gas tight cover on 1st chamber)

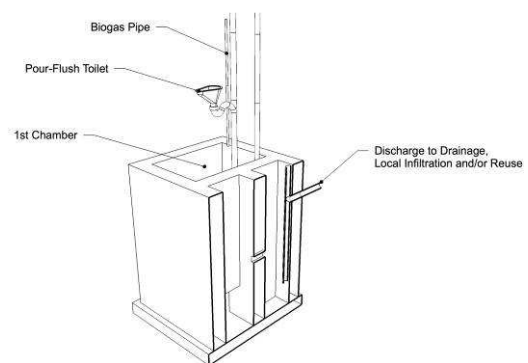
Design of Malaprabha Biogas Plant (figure 1 and figure 3) was done by Dr S.V. Mapuskar in 1980 and for the first time installed in a multi-storeyed building in Dehu village in Maharashtra's Pune district, India. The family uses the toilet-linked biogas plant ever since and utilizes biogas in compliment to Liquefied Petroleum Gas (LPG). The effluent is drained to the drainage system.

The design of Malaprabha Biogas Plants is governed by the average number of users a day, the amount of water used for flushing (and anal cleansing) per person per day and a hydraulic retention time (HRT) of 45 days. Thus digester volume equals number of users into litres of water used for flushing (and anal cleansing, if applicable) per person per day into 45 days HRT. For digestion of night-soil (i.e. excreta), optimum requirement of water is 2.17 litre per person. However, actual blackwater production strongly depends

upon the flush system used and may differ from case to case.

The biogas plant comprise of 3 compartments. The first compartment is designed to provide for a HRT of 30 days and doubles-up as gasholder. In order to collect the biogas that is generated in the process of anaerobic digestion of blackwater, the first compartment is provided a gas tight cover made from reinforced cement concrete (R.C.C.). The second and third compartment provide for a total HRT of 15 days. The chambers act as compensation chambers and facilitate build up of gas pressure. There is an opening at the bottom of the wall separating the 1st and the 2nd chamber and an aperture in the wall separating the 2nd and 3rd chamber to facilitate flow of water through the biogas plant (figure 3). The opening (1st to 2nd chamber) provides access to the sealed 1st compartment during construction and doubles-up as maintenance opening afterwards.

The biogas plant is provided a pressure release pipe that vents biogas before excess gas pressure may damage the plant.



(source: M. Wafler)

figure 3: Cut-away view of Malaprabha Biogas Plant (without gas tight cover on 1st chamber)

Depending on site conditions, the effluent from Malaprabha Biogas Plants may be drained to an existing drainage system, infiltrated locally or collected for reuse.

Design of Malaprabha Biogas Plant (serving a 10-person household) is exemplified based upon an assumed specific blackwater production of 5 litres per person per day. Net volume of the biogas plant is about 2.3 m³. Possible dimensions of Malaprabha Biogas Plant are given below. However, actual dimensions may be adapted to fit site conditions. Clear inner dimensions of the 1st chamber are 1.25 x 0.90 x 1.90 m (length x width x height). Within the inner clear height of 1.90 m (chamber bottom to gas tight cover) of the 1st chamber a dead space of 0.30 m and a gas storage volume equal to 0.30 m height (about 300 litres) is considered. The 2nd and 3rd chamber are 0.50 x 0.50 m in length and width, each. Water level (vertical distance from bottom of chambers to invert level of outlet pipe is 1.60 m.

Please note that design of Malaprabha Biogas Plants serving a few people only may be governed by practical considerations such as accessibility of chambers.

Adequacy

Biogas generation from blackwater serves a dual purpose of providing energy and helping manage human waste. Human nightsoil is a good substrate for generation of biogas. However, nightsoil from 25 - 30 persons per day is required for generation of 1 cubic metre (i.e. 1,000 litres) of biogas per day. Therefore biogas production from individual toilets that are used by 5 - 6 persons a day will cater for cooking energy demand of 1 person only.

Keeping this in mind, a new strategy has been evolved in Dehu village, where some families allow their neighbours to use their toilets for a nominal maintenance charge making attached biogas plants economically viable. By letting neighbours use their latrines, the owner benefits in three ways: 1) he gets maintenance charges from the user

families, 2) He uses the biogas generated in his own kitchen and 3) wherever possible, the recovery of manure is also an advantage [1].

Health Aspects/Acceptance

Salmonella typhii, a pathogen found in human excreta, can survive for up to 6 weeks in anaerobic conditions. Thus, from a health point of view and to ensure a pathogen free effluent, Malaprabha Biogas Plants are designed to provide for a hydraulic retention time (HRT) of 45 days.

Maintenance

Beneficiaries themselves do day-to-day maintenance. Depending upon number of users excess sludge has to be removed (using a suction unit) once in a while.

Pros & Cons

- + Reduced environmental pollution
- + The cost of construction of a human nightsoil-based biogas plant is comparable to the cost of a septic tank
- + Due to rectangular shape, Malaprabha Biogas Plants can be installed inside the house
- + Owner can do day-to-day maintenance
- Acceptance of biogas generated from human excreta

References

- [1] Dr S V Mapuskar (unknown). Making nightsoil-based biogas plants viable in Maharashtra's Pune district. Available: http://indiasanitationportal.org/resources/case/Biogas_Edited20th%20july.doc (last accessed: Dec. 6th, 2009)



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