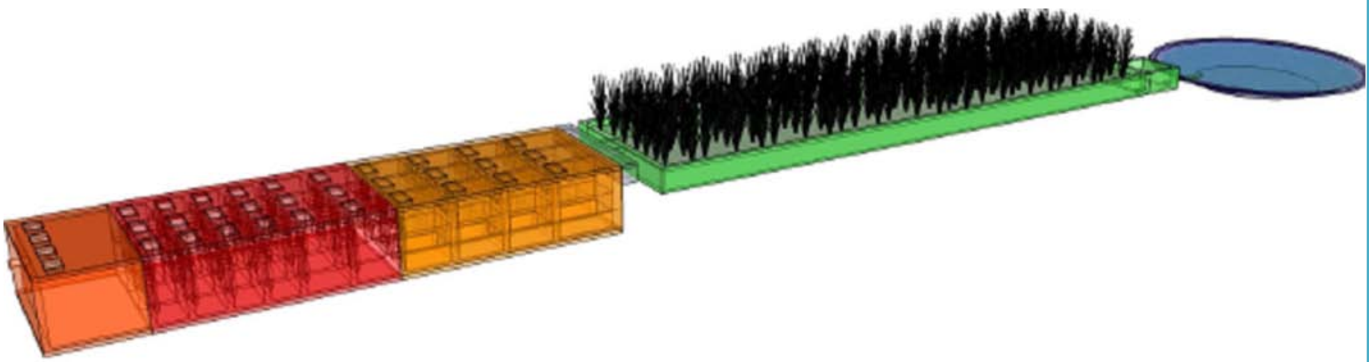
Decentralized Treatment Systems
DTS



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ECOSAN SERVICES FOUNDATION

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I. Introduction

A Decentralized Treatment Systems (DTS) treats wastewater making maximum use of natural gifts like gravity, microbiological activity or temperature. This result in a system which can work without technical energy input (in fact it's producing energy in form of methane/biogas) and needs only minimal maintenance. DTS application provides state of the art technology at affordable prices because material/inputs used for construction are locally available.

[A] DTS applications

- Provides treatment for both, domestic and industrial sources;
- Reliable, long lasting and tolerant towards inflow fluctuation;
- Do not need sophisticated maintenance;
- Reliable solutions for urban as well as for peri-urban and rural places.

[B] Treatment steps

Without considering facilities for necessary chemical pre-treatment of wastewater from industries, the DTS core system consist of four treatment steps:

- Primary treatment and sedimentation
- Secondary treatment in Anaerobic Baffle Reactor (ABR) and Anaerobic Up flow Filter (AF)
- Tertiary treatment in aerobic/anaerobic subsurface flow filter (Plated Gravel Filter)
- Tertiary aerobic/anaerobic treatment Polishing Pond

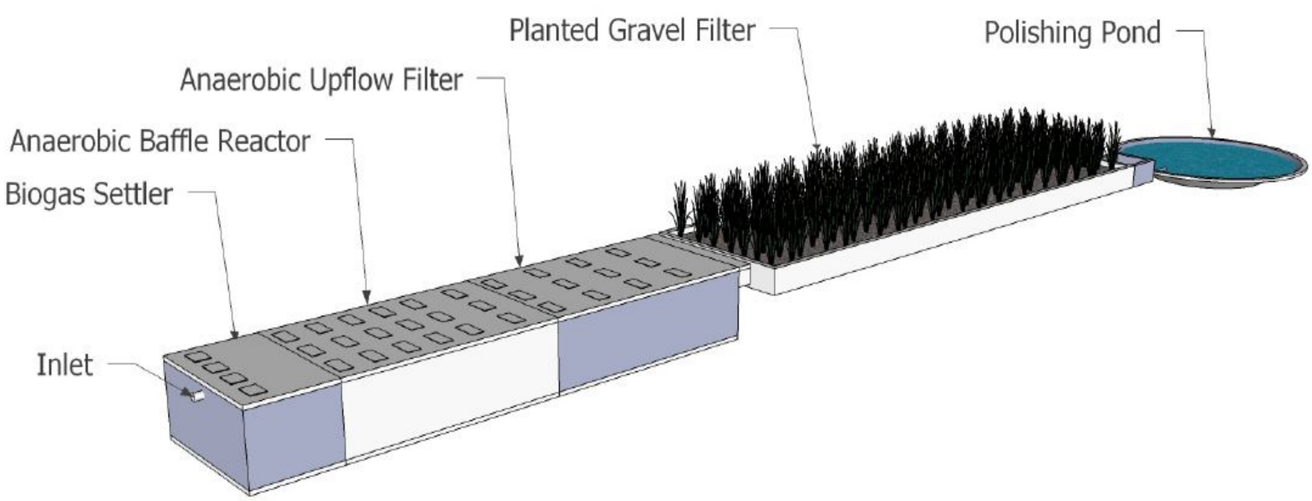

Figure 1: Decentralized Wastewater Treatment System

II. Ecology of a DTS

DTS requires no process energy for treatment but produces energy (biogas/methane). The construction is just civil work (walls, pipes and some filter material like gravel) containing no electrical components like pumps, aerators, agitators etc. Hence it is an eco-friendly solution helping to prevent global warming, energy dissipation and pollution of the environment. DTS enables reuse of the contents of the wastewater (water, nutrients and energy) and can therefore be considered as technical option for ecological/sustainable sanitation. It is possible to design the DTS in such a way that organic waste (e.g. from the kitchen) can get added, which gives you a clean solution for your organic waste and enhances the biogas production.

DTS applications are designed to meet requirements stipulated in environmental laws and regulations.

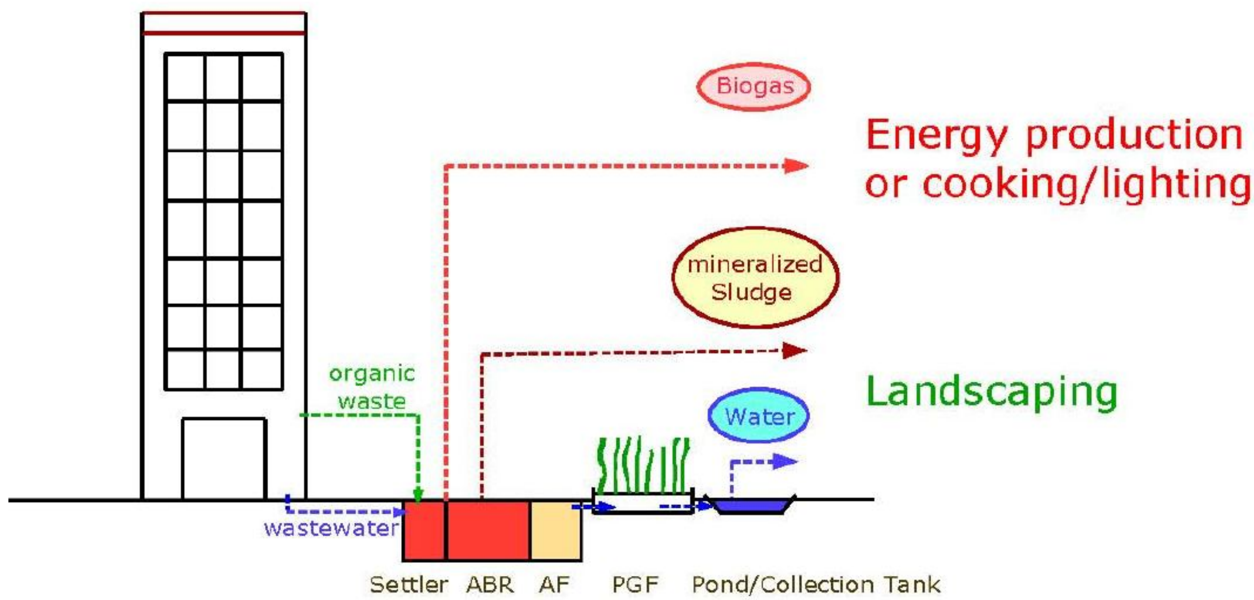

Figure 2: Ecology of DTS

[A] Description of the treatment modules

The selected treatment modules are based on DTS principles incorporating the following attributes:

- Tolerance to inflow fluctuations;
- Resource efficiency and non-dependence on energy;

- Minimal maintenance;
- Reliability and longevity;
- Reuse of wastewater and its contents.

[B] The modules proposed are

- Biogas Settler;
- Anaerobic Baffle Reactor (ABR);
- Anaerobic Up flow Filter (AF);
- Planted Gravel Filter (PGF);
- Polishing Pond.

- ## Biogas Settler

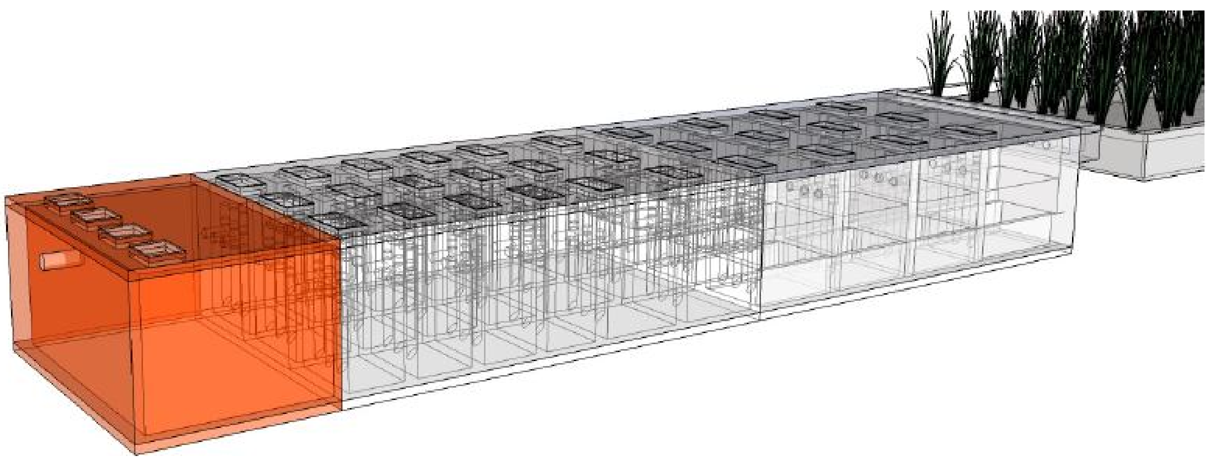

Figure 3: X-ray view of biogas settler

The settler can be considered as a gas tight septic tank with low hydraulic retention times. Two main treatment processes take place:

1. Mechanical treatment retains contaminants by sedimentation/flotation, and the wastewater from the clarified layer flows through the outlet
2. Biological treatment through anaerobic microorganisms which partially decompose the organic pollutants. The digestion process ensures that the accumulated sludge is reduced and stabilized. Storage volume for sludge is provided for 18 to 24 months, defining the desludging period.

Average reduction of organic content (BOD, COD) is between 25 and 40%. The produced methane can get captured in form of biogas and be used as an energy source in direct application or electricity production via gas-generator. The settler is resistant to shock load and variable inflow.

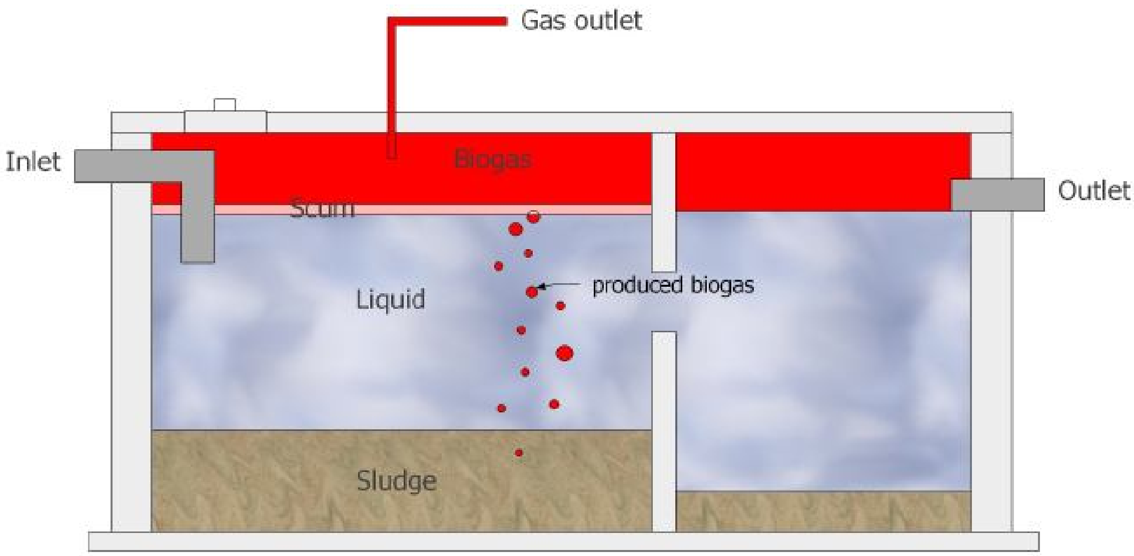

Figure 4: Cross – sectional view of Biogas Settler

- ## Anaerobic Baffle reactor

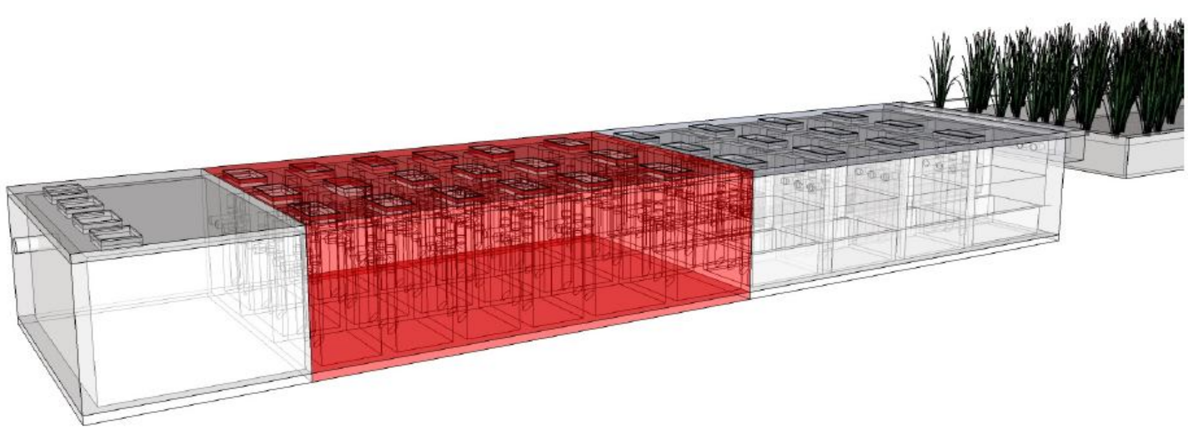

Figure 5: X-ray view of Anaerobic Baffle Reactor

The ABR consists of a series of chambers, in which the wastewater flows up-stream. Activated sludge is located at the bottom of each chamber. The inflowing effluent is intensively mixed up with the sludge, wherein it is inoculated with bacterial mass which decompose the contained

Pollutants. The BOD reduction rate of the baffled reactor is up to 90 %. The Baffled Reactor is resistant to shock load and variable inflow, the operation and maintenance is simple and virtually no space.

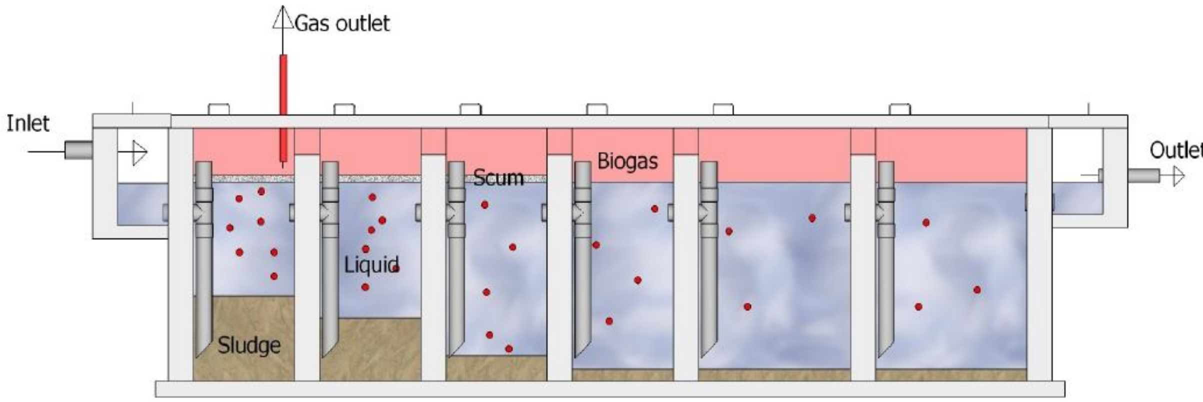

Figure 6: Cross-sectional view of Anaerobic Baffle reactor

- **Anaerobic Filter**

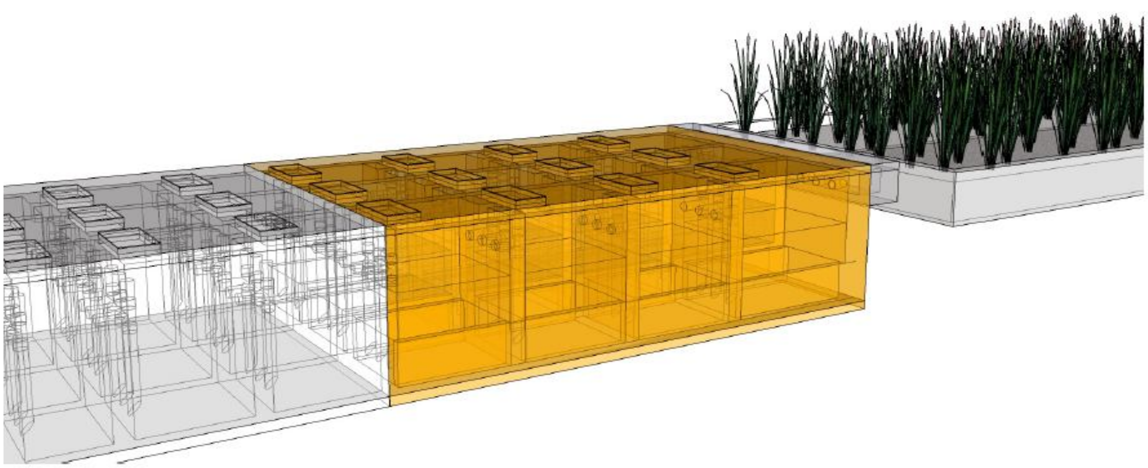

Figure 7: X-ray view of anaerobic filter

The anaerobic filter is also known as fixed bed or fixed film reactor and has a similar flow pattern like the Anaerobic Baffle Reactor. Some filter materials such as gravel, rocks or specially formed plastic pieces provide additional surface area for bacteria to settle. Non-settleable and dissolved solids are treated by bringing them in close contact with a surplus of active bacterial mass fixed on filter material. The BOD removal rate is in the range of 70-90%. The surplus of activated sludge produced has to be removed in intervals of 1 to 3 years. The AF has his strongest in further stabilization (BOD, COD, TSS reduction) of low strength wastewater e.g. the effluent from the ABR.

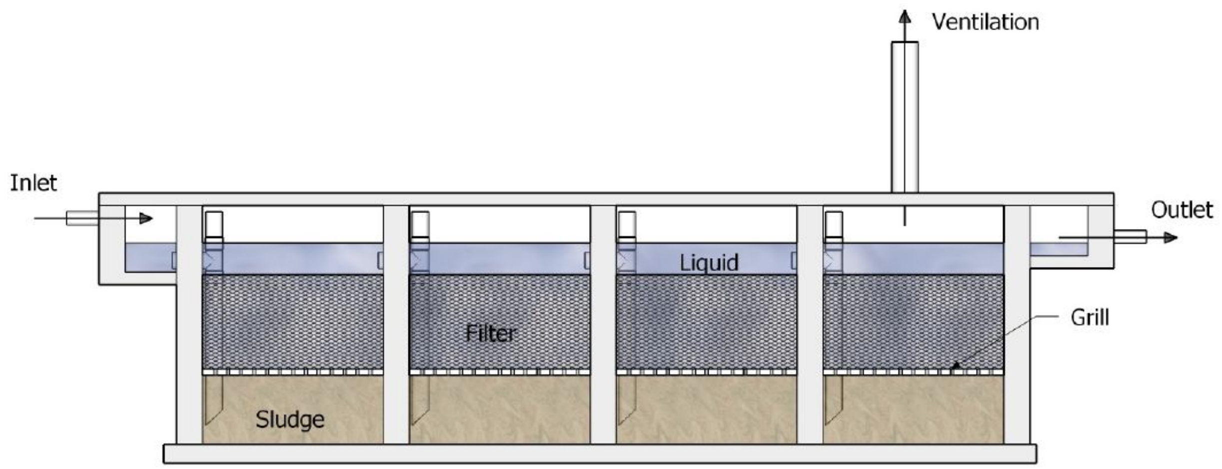

Figure 8: Cross-sectional view of Anaerobic filter

- **Horizontal Flow Constructed Wetland / Planted Gravel Filter**

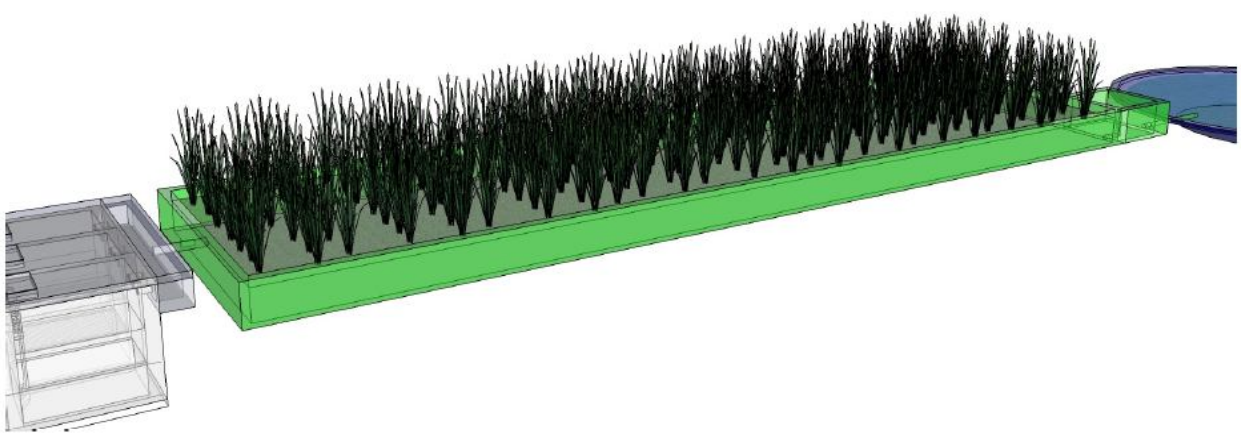

Figure 9: Planted Gravel Filter

The Horizontal Grave Filter (HGF) is made of reed planted filter bodies consisting of fine gravel. Bottom slope is 1 %. The flow direction is mainly horizontal. The filter is normally planted with helophytes like cattails or reeds. The main removal mechanisms are biological conversion, physical filtration and chemical adsorption. Mechanisms of BOD removal are mainly aerobic and anoxic .The function of the HGF is mainly post treatment. Reduction rate of BOD is between 75 - 90 %. Reduction of infective organisms is over 95 %. Operation and maintenance of the system is simple (mainly garden work). The spatial requirements are compensated by integrating it with the landscapes.

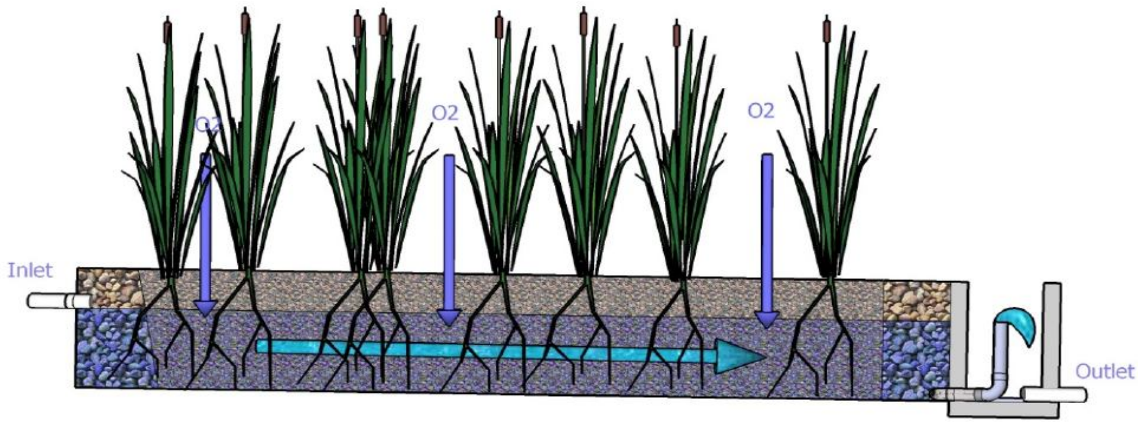

Figure 10: Cross – sectional view of Planted Gravel Filter

- **Polishing Pond**

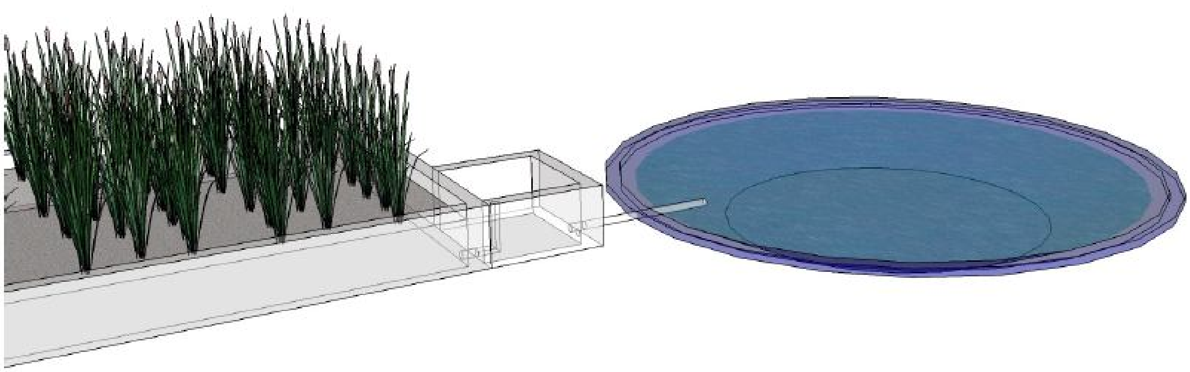

Figure 11: Polishing pond

Polishing ponds are shallow artificial lakes. The removal mechanisms are sedimentation of non-degraded and degraded suspended particles, and aerobic oxidation by intake of oxygen via water surface and photosynthesis of algae. The elimination of pathogens by exposure to UV ray represents the third treatment mechanism and often the most important one. The efficiency of polishing ponds is strongly related to their surface and their hydraulic retention time. The BOD removal normally ranges between 20 – 30% and the pathogen removal is 95%.

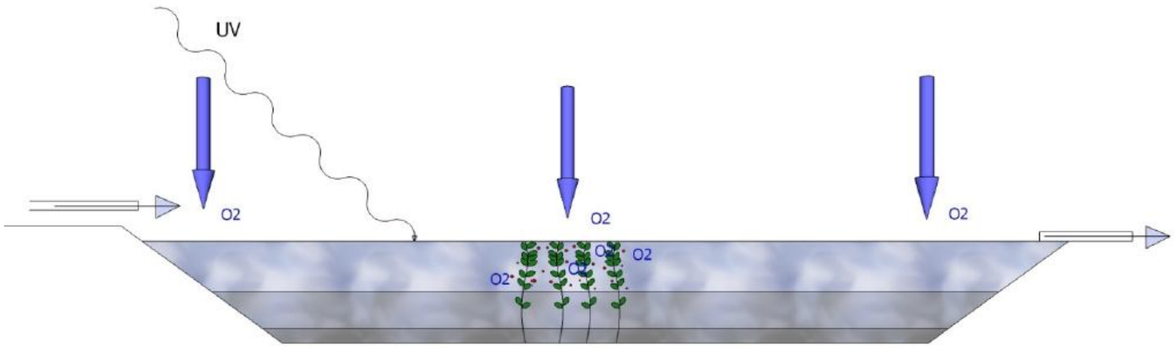

Figure 12: Cross-sectional view of Polishing pond

III. Treatment efficiency

A DTS reaches high removal efficiencies in terms of organic content (BOD, COD) and TSS. BOD effluent concentrations of less than 10mg/l are reachable, fulfilling national wastewater effluent standards (concerning organics).

The anaerobic treatment (absence of oxygen) disables a nitrification process; therefore the effluent of a DTS has similar nitrogen characteristics as the influent. The normal effluent of a DTS contains high levels of nutrients (N and P) and is therefore just right for irrigation purpose.
The pathogen reduction can be assumed in the range of 99.9% to 99.9999% (3 to 6 log); worm eggs, which have statistically the highest health risk, get reduced 100% because of settling process in the tanks and the good filter effect of the gravel filter (PGF, HGF).

NK

Analytical & Pollution Test Center

Report of Analysis

Report No.: 10/05 **Date:** 22/01/2010

Name of the Company: Ecosan Services Foundation
Site: Kamalini Kutir

Type of sample: Sewage

Your Ref. No.: Personal discussions with Ms. Sampada Kulkarni

No. of Samples: Two

Date of receipt of sample: 18/01/2010

Sample collected by : Party

Sr. No.	Parameters	Number & Type of sample Inlet	Outlet			MPCB Std.
1.	pH	6.56	6.77			**5.5-9.0**
2.	Suspended Solids	566.0	18.0			**100.0**
3.	COD	2976.0	96.0			**250.0**
4.	3day BOD @ 27oC	1550.0	23.2			**100.0**
5.	Organic Nitrogen	86.80	45.0			---
6.	Total Nitrogen	89.5	45.0			---
7.	Phosphates	6.75	1.7			**5.0**

(All values except pH are in mg/l)

Analyst **Lab in-Charge**

Note : This analysis report is exended as Tehnical Assistance only & N K Analytical & Pollution Test Center is not responsible for any dispute arising out of this report

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Figure 13: Water analysis results of effluent from DTS at Kamalini Kuteer resort

IV. Space requirements

If integrated well into the existing structure, the space required for the DTS is not lost space. On the underground construction (Settler, ABR and AF) e.g. a parking space or playground can get established; Wetland and Pond can get integrated as a part of the Landscaping concept, astatically appealing and ecologically invaluable.

To treat 100m3 wastewater per day, the DTS requires for:

- ✓ septic tank: 0,5 m2/m3 daily flow
- ✓ anaerobic filter, baffled septic tank: 1 m2/m3 daily flow
- ✓ constructed wetland: 4-7 m2/m3 daily flow
- ✓ anaerobic ponds: 4 m2/m3 daily flow
- ✓ polishing ponds: 25 m2/m3 daily flow
- ✓ Underground construction, the space can be used as e.g. parking space, play ground or simply covered with a plastic sheet and lawn on it.

V. Costs

[A] Construction costs

The initial costs for the construction of a DTS are in general lower or comparable with conventional aerobic systems, since no mechanical or electrical items are required and the costs for collection and discharge of the wastewater (sewer pipes) are much lower. The costs per 100m3/day are between INR 13 and 25 Lakhs (20,000 to 40,000Euro); including all costs for the construction.

[B] Running Costs

Since a DTS requires no process energy and the maintenance of the systems is simple garden work for the wetland and desludging of the underground tanks (every second year), the running costs are much lower than for conventional systems (5 to 15% of a conventional systems), depending manly on the costs for the desludging tanker.

VI. Projects

[A] Adarsh College of Arts & Commerce, Badlapur

Volume: 8m3/day

Discharge standard: BOD <25mg/l, TSS < 30mg/l

DTS is constructed for a day School with 2600 students. The campus gets used for cricket matches and wedding ceremonies with up to 1000 people. Treated wastewater is being reused for landscaping purposes.

Figure 14: DTS at Adarsha college

Figure 15: Reuse garden

Challenge 1: It is a day college and the toilet block was designed for the students and floating population attending weddings and other functions during college holidays. Thus quality of wastewater with respect to organic content would be less concentrated and also the quantity would vary as number of users fluctuates. The system was designed considering the above points. The biogas generated is also an incentive for the project as the volume generated can be reused only for demonstrative purposes.

Challenge 2: There is an open space in the premises where the treated wastewater can be reused for landscaping purposes. Moreover, the collected and stored urine could also be reused to develop a vegetable garden.

The DTS was implemented to cater to this requirement.

Figure 16: Exhibition hall

Challenge 3: The concept of ecological sanitation and its importance needs to be promoted amongst students and visitors. Thus, demonstration of the produced biogas and awareness with regard to reuse aspects is being done in the nearby Ecosan Exhibition Hall.

[B] Kamalini Kuteer Resort, District Pune

Volume: 5m3/day

Discharge standard: BOD <25 mg/l, TSS < 30mg/l

DTS is constructed for a resort which also provides lodging facilities for 25 people (10 fixed + 15 daily floating populations). The number reaches maximum of 30 during peak seasons. Treated wastewater is being reused for landscaping purposes.

Figure 17: Kamalini Kuteer resort

Challenge 1: Being a resort, the number of visitors as well as their methods of usage of different sanitation facilities varies. Thus, the wastewater production also differs from season to season.

Figure 18: DTS at Kamalini Kuteer

Challenge 2: The resort is located on the banks of river Kanindi. The wastewater generated was earlier being discharged on the banks which indirectly was a threat to quality of river. Thus, the owner was interested to reuse the wastewater generated in the premises itself to grow a vegetable garden as well as for landscaping purposes. This would not only conserve fresh water required for the same but also would keep the river free form pollution. The DTS has been designed in accordance to the client's requirement.

Figure 19: Vegetable garden

Challenge 3: If the resort has a sustainable wastewater treatment plant, it will not only attract more visitors but also help replicating the ideas and creating awareness with regard to sustainable sanitation.

[C] Oasis Resort, Pune

Volume: 10m3/day

Discharge standard: BOD <25mg/l, TSS < 30mg/l

DTS is constructed for a resort which caters about 700 people in a week and about 800 – 1000 people during weekends and functions (includes permanent 70 staff members of which 35 workers stay in the resort). There are no lodging facilities for customers in the resort. Treated wastewater is being reused for landscaping purposes.

Figure 20: Oasis resort entrance

Challenge 1: The resort mainly generates kitchen wastewater, which contains maximum of oil and food materials; than black water from the sanitation facilities as no lodging facilities are provided. As the resort also caters for functions like weddings, official parties etc.; the wastewater production differs from time to time.

Figure 21: Oasis restaurant

Challenge 2: The resort had a treatment system which was unable to treat the generated wastewater properly thus creating odour in the premises. The owner therefore wished to implement a more efficient system than the earlier one. Thus, the DTS was designed considering the basic structure of the earlier system. The owner also wished to reuse the treated wastewater in the premises to grow a vegetable garden as well as for landscaping purposes, thus conserving fresh water required for the same.

Figure 22: DTS at Oasis resort

Challenge 3: If the resort has a sustainable wastewater treatment plant, it will not only attract more visitors but also help replicating the ideas and creating awareness with regard to sustainable sanitation.