

VIABLE LOW COST TECHNOLOGY OPTIONS FOR HUMAN WASTE DISPOSAL

SYSTEM 1 - HORIZONTAL CYLINDER TYPE

T.B. Madugalle, and H. Pinidiya

This report describes two alternative approaches for the disposal of human waste and is based on the field experiments conducted in Sri Lanka. The basic scientific principles of the designs of the selected septic tank systems and the important aspects that will ensure the most efficient functioning of the system and disposal of the effluent are discussed. The influence of 2 scientifically designed sewage disposal system and important factors such as construction and operation are highlighted, cost estimates and the useful data of the systems are described, accompanied by drawings with dimensions. Visual observations and the possibility of applying the principles of percolation to soils relatively impervious to water as well as to the areas with high water tables are pointed out.

INTRODUCTION

In developing countries some special requirements are necessary over and above the conventional sanitation methods. With the increasing health consciousness and need for better sanitation, human waste management has assumed special importance.

The majority of the population living in the developing countries do not even have the rudimentary level of sanitation facilities. The lack of sanitation and especially the problems arising from it are most acute in the urban areas. Until recently, the solution to the human waste management problem in Urban areas was considered to be the conventional sewage system. This view was held by several agencies and international Organisations. The enormity of the task in terms of its size and cost is such that all the best efforts using only the conventional sewer system have not been able to satisfy this basic necessity. It is becoming increasingly evident that in most developing parts of the world, sewerage will be affordable only for a limited population. A range of sanitation systems and a systematic approach for their application, therefore needs to be considered.

The general population in the developing countries has limited technical knowledge and therefore not realistic to propose a complicated toilet system to function with much maintenance and service. It is also quite evident that the cost factors decide the suitability of the system.

SELECTED SYSTEM

The selected system deviates from the conventional septic tank and eliminates several construction problems by lowering the cost involved.

Septic tank is actually a very complex system with physical, chemical and biological processes, although it is generally considered a very simple concept. The septic tank provides for the separation, storage and digestion of suspended solids as well as for the growth reproduction and death of large numbers of anaerobic organisms. During the sedimentation process in a septic tank it is likely that the four general types of settling phenomena takes place simultaneously. (7).

The selected two alternative systems in which only human excreta and nominal amount of flushing water are passed through the two compartments in a series.

The general principal behind the system is very simple but effective and the structure can be easily constructed because of the prefabricated components.

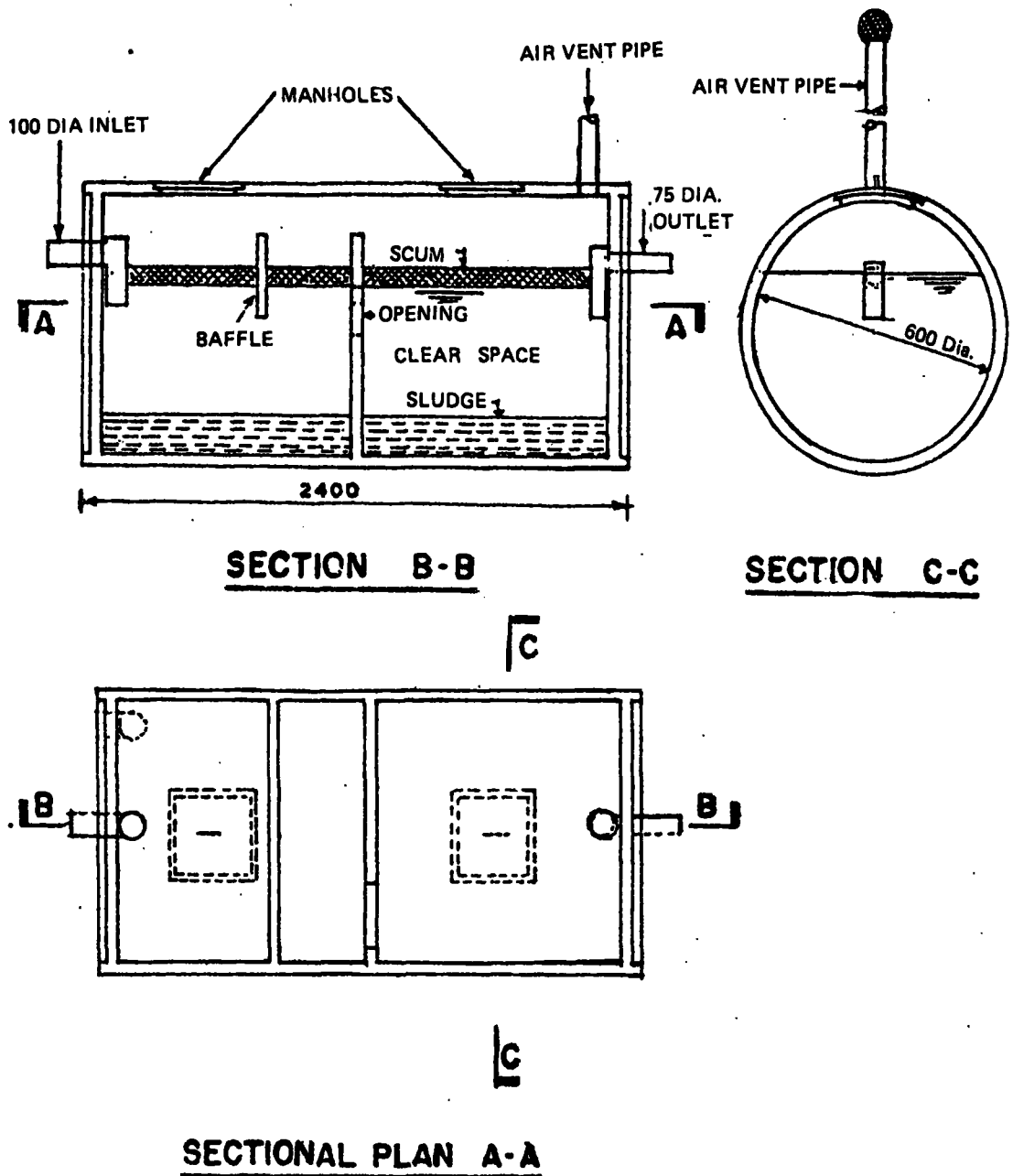
A horizontally placed tank comprises of two compartments (fig.1) and the inlet is lead from the water seal latrine to the first compartment with a 't' joint at the end. Sludge is collected at the bottom while scum accumulates at the uppermost surface of the tank. Liquid for the second compartment is flown through the opening which is made at the middle of the separation wall. This opening at the middle separation wall permits the flow of liquid from the clear space to the next compartment without disturbing the scum layer at the surface.

Capacity of the tank is approximately 135 gallons (608 litres) with 2 ft. diameter (609 mm) and 8 ft. (2.5 m.) in length. Cover slabs are provided at the top in both compartments for easy operation and Vent pipe is introduced to escape the gases formed inside the tank during the fermentation.

QUALITY OF EFFLUENT IN SYSTEM 1

Several tests were carried out at the National Water Supply & Drainage Board laboratory to ascertain the quality of effluent of the system. Influent contained more than 400 mg/l of suspended solids.

Approximately 60% to 70% reduction of 5 day Biochemical Oxygen Demand (BOD) and suspended solids were observed during the tests conducted. It was found that effluent is free from any odour throughout the year irrespective of the weather.



HORIZONTAL CYLINDER SYSTEM

FIG.1

SYSTEM 2 - VERTICLE CYLINDER TYPE

This system consists of two separate tanks (fig. 2) made out of precast concrete pipes of diameter 2.5 ft. (760 mm). Base of each tank is tightly sealed to prevent any kind of leakage from both tanks. Manholes are provided for each tank at the top cover slab for easy operation and an air vent pipe is connected to the first tank. The

tanks are normally circular in shape but could easily be rectangular.

The first tank of the system serves as a settling chamber for the heavier solids and in the second tank the excreta is liquified and undergoes fermentation.

The design of the system ensures that even during the periods of the maximum consumption the excreta undergoes at least 20 days of anaerobic treatment with the capacities provided in first and second compartments.

EFFLUENT QUALITY IN SYSTEM 2

Samples were drawn-off from the system frequently and chemical analysis were carried out in order to evaluate the effluent quality of the system. Liquid temperatures were generally 29 C at the day of analysis. More than 400 mg/l suspended solids were observed in the influent prior to the initial tank.

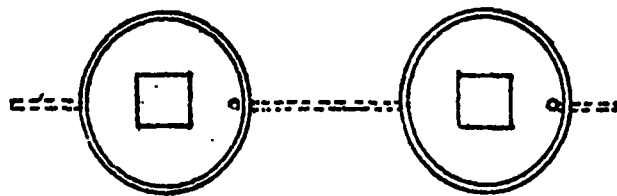
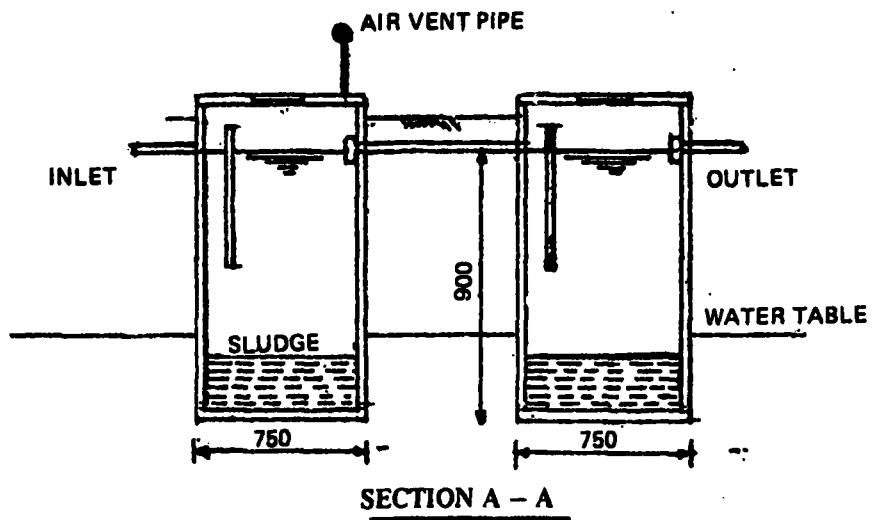


FIG. 2a

FOR AREAS WITH LOW WATER TABLE

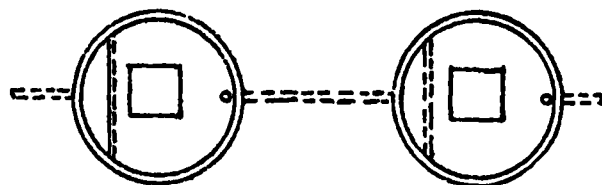
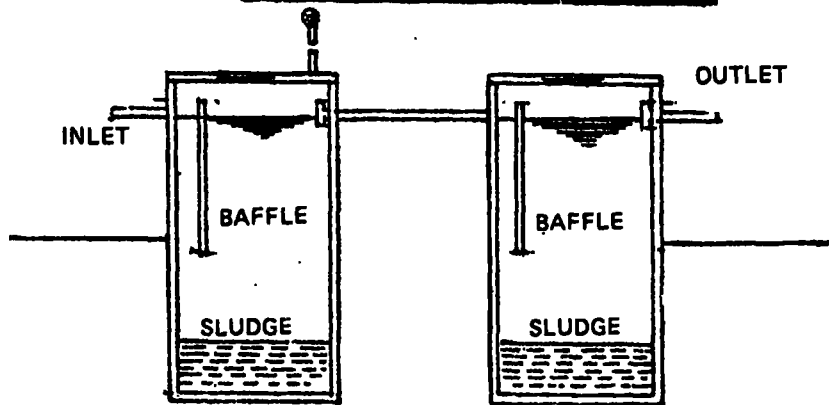


FIG. 2b

FOR AREAS WITH HIGH WATER TABLE

VERTICAL CYLINDER SYSTEM

FIG. 2

Comparison between incoming and outgoing waste indicated a purifying effect of around 60% for BOD and 60 - 70% of suspended solids. Effluents were relatively free from any kind of odour.

SHAPE OF THE TANKS

In both systems the circular shape tanks were adopted for the field experiments because of several advantages.

The circular shape tanks are:

- (a) Easy to handle
- (b) Readily available
- (c) Cheaper
- (d) Easy and quicker for constructions

DISPOSAL OF EFFLUENT

Several lives may be found in the sewage effluent. The presence of hookworm and ascaris eggs in septic tank effluents poses a potential health hazard. Therefore it is necessary to introduce a proper method for the disposal of the effluent to overcome this problem.

Soakage Pit and the tile field were used to dispose the effluent in both systems experimented. Generally the sewage effluent percolates through the soil and eventually reaches the ground water. This infiltration is a kind of treatment, that is generally used for sewerage treatment. This treatment, is one of the methods having an immense potential for developing countries. Vegetation may or may not be required for this system. The main advantage of this method is the minimum land requirement for disposal of the effluent.

The soakage pit adopted for the field experiment used open bricks in all four walls and the bottom is unsealed to ease the effluent to reach the soil surface.

COST ESTIMATES FOR THE SYSTEMS

SYSTEM 1		SYSTEM 2	
Item	SLRs.	Item	SL.Rs.
1. Excavation	50.00	1. Excavation	50.00
2. Horizontal tank (Hume Pipe) all inclusive	1990.00	2. Hume Pipes (762 mm)	1400.00
3. Pipes specials etc.	350.00	3. Concrete for base and cover slab	650.00
4. Soakage Pit	250.00	4. Pipes and Specials	150.00
5. Sundries	60.00	5. Soakage Pit	250.00
		6. Sundries	100.00
	TOTAL		TOTAL
	2700.00		2600.00

Tile field is prepared with clay (E.W.) pipes which are normally available in the market at a cheaper rate. Each pipe piece is connected up with open joints to allow flow of effluent to the soil through them. Rubble is packed completely around the clay pipes to prevent soil clogging which could cause serious pollution problems in the surrounding areas.

CONDITIONS OF SOIL

Soil properties are important factors in identifying and selecting sites for an economical and effective system. Absorption capacity of different soils and its effects vary the design of the soakaway system and hence the costs involved.

It was observed that the physical and hydraulic properties of solids play a big role in the selection of the site.

The behaviour of the sub-surface permeability,

- (a) Exceeds or equals infiltration rate : Infiltration rate limiting
- (b) Less than infiltration rate : May limit application rate

BEHAVIOUR WITH CLIMATE

The system works most efficiently throughout the year irrespective of the weather conditions. However in a tropical country like Sri Lanka a wide range of variation in the weather may never be expected and the behaviour of the system may not respond accordingly.

EFFECT WITH HIGH WATER TABLE

It was observed that the system is very successful even with high water table as the top most soil is used for percolation of the effluent. The entire system is placed above the soil surface as far as possible in order to obtain the maximum elevation above the water table. To achieve the maximum hydraulic gradient outlet of the squatting pan immediately after the water seal is connected with a 'P' trap to inlet pipe of the septic tank without lowering the pipe upto the soil surface. Sewage effluent from the soakage pit transmit into the unsaturate zone by keeping the outlet at a higher level. Soil surface around the soakage pit is filled-up with earth and the effluent from the soakage pit percolate into the soil through the open bricks.