

## R F CARROLL

### IMPROVING THE PIT LATRINE

#### 1 INTRODUCTION

The main expectation of a sanitation system is the disposal of excreta without contact with or nuisance to members of the community. A fundamental criterion necessary to preserve public health and comfort is the isolation of human excreta from other people, insects and animals until it is rendered harmless and inoffensive.

The pit latrine is the most widely used excreta disposal system in developing countries today, although still secondary to defaecation in fields or bush. Badly constructed pit latrines can become offensive due to odours and fly and mosquito nuisance. Also health hazards exist with some installations, resulting from access to the pit contents by insects and animals. If disease organisms are present then they can easily be transmitted over a wide area by these carriers. Pit collapse is a common problem, particularly where heavy superstructures are built and the supporting ground is unstable.

Shortcomings of pit latrines are frequently reported, and the purpose of this paper is to consider improvements in design and construction to improve the comfort, safety and effectiveness while at the same time achieving an economical unit cost.

#### 2 POLLUTION FROM PIT LATRINES

There is some recent evidence(1) that groundwater pollution can occur from pit latrines installed in certain ground situations. In areas with fissured rock or other types of highly permeable ground or where pits penetrate the groundwater, high nitrate levels and high bacterial counts can occur and could present dangers to human health. In areas where hazards exist, it is important that a safe water supply is made available from an uncontaminated source if pit latrines are the only affordable method of excreta disposal.

It has however been shown by such authorities as Baars(2) that the passage of contaminated water through soil generally has a filter effect in removing harmful organisms that may contaminate boreholes and wells.

Possible sources of groundwater pollution, such as pit latrines, should be sited with care in relation to water sources and recommended safe distances should be observed(3).

#### 3 A NEW APPROACH TO PIT LATRINE TECHNOLOGY

As new housing plots tend to be smaller as time goes on, due to a growing shortage of land, particularly in the semi-urban areas created by development of land for 'site and services' schemes, the traditional practice of digging a new pit when the first one is full may not be practicable. Also if standards of design and construction improve, giving greater comfort conditions with improved stability of pit and superstructure, then the rebuilding of the latrine every few years is wasteful of effort and material resources.

One approach could be to empty pits for re-use rather than excavate new ones. The practice of emptying pits for re-use is not entirely new; in some countries single pits have been emptied by first flooding the 'full' pit with water and then extracting the diluted contents by cesspit emptier (vacuum tanker). There are considerable health hazards in this practice, since the top layers of the pit contents will not be decomposed and are likely to contain viable organisms harmful to health.

By sealing off a pit after a period of use and retaining the contents long enough for pathogens to die off, the material then excavated would be harmless and inoffensive.

To achieve this it is proposed that double pits be employed, used in turn for a period before sealing off, the contents then left for a further maturing period before emptying.

If double pits that can be emptied are used, excavations smaller than traditional pits will suffice, with correspondingly reduced labour and material costs for the supporting structure. For example, at a designed capacity of 1.5 m<sup>3</sup> effective volume, a compartment should last a family of five persons for around three years. This calculation is based on two thirds of 'actual' pit volume being used as 'effective' volume(4).

Pit emptying should be carried out without the addition of water, since water is normally a scarce resource and its addition will also increase the volume of material to be extracted

and transported to disposal.

By constructing shallower pits there will be less risk of penetrating the groundwater, less side area for percolation of contaminated liquids into the ground and indeed less stored material that is possibly a pollution source.

#### 4 EXPERIMENTAL DOUBLE PIT LATRINE

To develop the concept of permanent and emptyable pit latrines, prototype designs have been prepared, designated the 'PIP latrine' (Permanent Improved Pit latrine). The basic design is the PIP type A, illustrated. A prototype has been constructed at the Building Research Establishment to verify construction details and to investigate the effectiveness of alternative pit ventilation arrangements.

The main features of the PIP latrines are:

- (i) Small double pits, each 1.5 m<sup>3</sup> effective volume.
- (ii) Pit tops and superstructure supported.
- (iii) Pits ventilated, to reduce odour and insect nuisance.
- (iv) Mechanised or manual emptying.
- (v) Two year retention period.
- (vi) Three year emptying cycle.
- (vii) Pit contents decomposed, harmless, inoffensive and useful as a fertiliser.

A major departure from traditional pit latrine practice is that PIP latrines are designed to be emptied. Double pits are used so that a period of 2 years can elapse before the last deposited material is excavated. If the average pit is filled in 3 years, this retention period means that the bottom layer of pit contents will be at least 5 years old, reducing through the depth of material to the topmost layer which will be at least 2 years old.

The human gut is the ideal host environment for survival and breeding of many pathogenic bacteria and parasites that are the cause of much poor health, particularly in the developing countries. Pathogens that may contaminate fresh human excreta will die-off during a retention period exceeding 9 months in a pit latrine(3) due to the unsuitable environment. It is proposed that a retention period of around 2 years be adopted, as an added safeguard to health.

The construction sequence for a PIP type A latrine is illustrated by the figure:

- 1 Initial shallow excavation, 350 mm deep, with level bottom.
- 2 Concrete liner, 500 mm deep x 100 mm thick, cast in shutters on undisturbed ground.
- 3 Pits excavated within liner and partition wall constructed up to the underside of the liner.
- 4 Precast concrete floor panels (2) and access covers (4) assembled.
- 5 Superstructure erected on floor panels. Separate ventilation pipe with insect screen to each pit.

- 6 Mechanised pit emptying or may be manually emptied.

#### 5 PIT EMPTYING

Because of the shallow depth of PIP latrines it is feasible to empty the compartments manually, using long-handled shovels. However, in many cultures this is socially unacceptable even though the decomposed material in the pit should be almost odourless and inoffensive, similar in texture to friable soil if the pit is above the water table. If the pit is wet the resulting slurry should also be harmless and have little offensive odour after two years retention.

Mechanised emptying of pit compartments is planned for an experimental project in Botswana. As part of the research programme an emptying machine will be supplied to provide a three year emptying cycle for these double pit latrines. The machines envisaged will work on a high volume air flow principle, that will draw all types of material, ranging from light dry material to wet sludge, according to the groundwater conditions in the pit at the time of emptying. The suction unit is based on a centrifugal fan, passing only filtered air. No abrasive material will pass through the rotor of the fan, thus ensuring a long life. Trials with such a machine, lorry mounted, will be carried out at BRS, to ascertain maximum horizontal distances over which a simulated pit material can be pulled by the machine. The suction hose is 200 mm dia and will pass all the common materials likely to be deposited in a pit latrine.

#### 6 PIT VENTILATION

So that odour nuisance is a minimum, as well as to reduce the attraction to insects to enter the system, it is desirable to create a flow of air in through the inlet hole and to discharge it together with foul gases through a ventilation pipe at high level.

Experiences reported from tropical countries have suggested that by siting a black painted ventilation pipe on the sunny side of a superstructure, solar heat would warm the air in the pipe, causing an upward flow. This upward movement would then draw air in to the pit through the inlet hole.

Experiments are planned during the collaborative project in Botswana to examine this solar effect, as well as the effects of wind blowing across the open end of a vent pipe. In the meantime however some measurements have been made in the BRE prototype latrine, choosing warm sunny days that gave an appreciable temperature increase of the air in the ventilation pipe.

The results obtained so far do not indicate a significant air flow difference, when comparing the flow in a solar warmed pipe with a cool pipe in shade. However, the wind blowing across the open end of the ventilation pipe, although very light on the days when measurements were made, produced corresponding peaks of air movement in the pipe.

Various venting arrangements will be tried out in the prototype latrine, using different pipe diameters. In addition the ventilation efficiency of a single pipe, shared by both pits, will be compared to that of individual pipes to each pit.

The preliminary results indicate that a pipe diameter of 100 mm gives a good air flow, even when partially obstructed by a flyscreen. This suggests that for a low-cost installation, the pipe could be a single straight length of 100 mm diameter, of any durable material, such as UPVC or asbestos cement, fixed at top and bottom. The pipe can be left self-coloured, but since solar heat absorbed by the pipe could be beneficial in encouraging an upward flow of air and gases, a black external finish to the pipe may be an advantage. This useful effect however may be overrated as already indicated and requires experimental work under tropical conditions to verify.

The outlet end of the pipe may require a terminal fitting if a downward component of the wind is expected. This is only likely if buildings or trees, taller than the ventilation pipe, are in close proximity to cause turbulence. A simple plate terminal located above the outlet should be adequate.

It is important to incorporate an insect screen in the ventilation pipe to prevent disease carrying insects from leaving the latrine. An effective screen can be made from stainless steel woven wire mesh (16 mesh x 28 SWG). This mesh has an aperture of 1.23 mm and should prevent insects such as houseflies and mosquitoes from emerging.

#### 7 RE-USE OF DECOMPOSED EXCRETA

It is hoped that, as a long term benefit, the decomposed pit contents will be used as a fertiliser and soil conditioner, so vitally needed in arid areas with poor soil. In Asia and the Far East generally, raw human excreta has been recycled to the land producing food crops for many hundreds of years. The practice has been accepted as a normal re-use procedure for a waste material even though until recently the health risks were not generally understood. Considerable progress has been made in recent years with composting techniques(5) so that the material being handled is considerably safer for application to land producing crops for direct human consumption.

Pit latrine contents, when properly broken down by bacteria and sufficiently matured to remove pathogens, are ideal for recycling, not least because of their inoffensive nature which it is hoped will encourage their application in gardens and possibly on a larger scale to farmland. Large scale collection would be necessary for farm use, since only small amounts would be available from domestic pit latrines at widely spaced intervals eg for the PIP latrine a three year cycle is planned.

The volume of fertiliser produced from an original 1.5 m<sup>3</sup> compartment would probably be less than one quarter of the original volume.

The final amount must depend very much on the nature of materials other than excreta going into the pit. Coarse woody vegetable material will take a lot longer to completely break down than light leafy materials. Other materials such as stones and plastics if they are put in will not reduce at all, but will add to the stored bulk.

#### 8 FURTHER INFORMATION

Final design recommendations and information on construction costs will be reported when the Botswana experiment is completed.

#### ACKNOWLEDGEMENT

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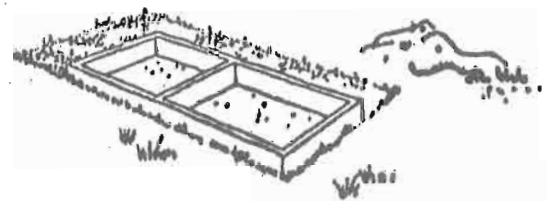
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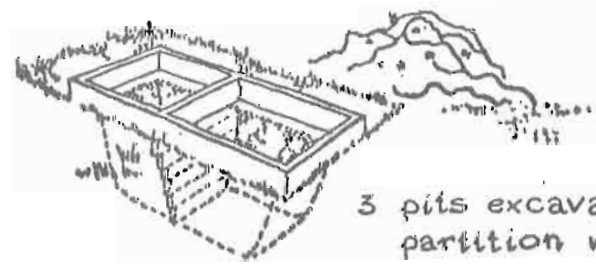
# PIP



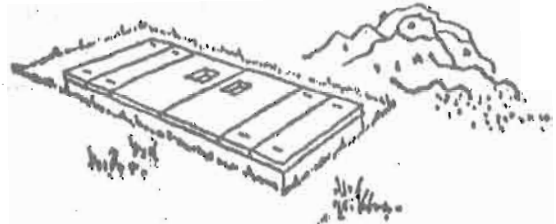
1 shallow excavation - level base



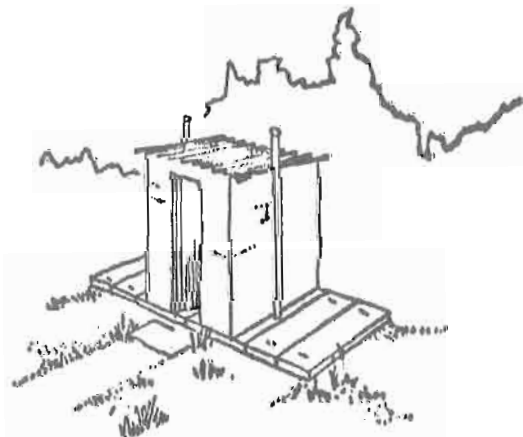
2 concrete liner, cast in shutters on undisturbed ground



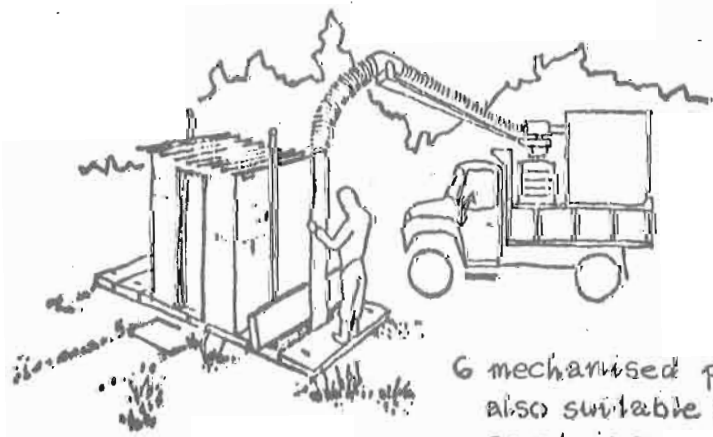
3 pits excavated within liner, partition wall constructed



4 precast concrete floor panels and access covers assembled



5 superstructure on floor panels; separate vent to each pit compartment



6 mechanised pit emptying; also suitable for manual emptying