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BREVAC: a mechanised method of emptying sanitation chambers

R F Carroll, CEng, MIMechE

To complement the development of permanent double-pit latrines in developing countries, the Building Research Establishment has developed a mechanised method for emptying all types of on-site sanitation system. This method dispenses with manual emptying, which is often offensive and hazardous to health. It is known as BREVAC and is based on a road tanker which has a suction system that combines a partial vacuum with pneumatic conveying.

Because of the capabilities of the system over a wide range of operating conditions, BREVAC is also suitable for desludging settlement tanks and lagoons.

INTRODUCTION

The term 'sanitation' can be defined as 'arrangements to protect public health, especially by efficient disposal of sewage'. Protecting and improving public health are currently the objectives of a considerable programme of work in the developing countries. This work aims not only to cure disease, but also to prevent disease by providing access to safe water and installing effective sanitation[1].

This paper outlines the work of the Building Research Establishment (BRE) in the area of low-cost sanitation to improve the basic pit latrine and to devise a new method of emptying sludges from the chambers.

THE PIT LATRINE

Upgrading the pit latrine

Cost and the availability of water preclude the provision of cistern-flushed sewered systems in many areas of the world. So considerable attention is being given to developing on-site sanitation systems that are likely to be affordable and can be constructed with locally available skills and materials. Pit latrines are the most widely used form of sanitation in developing countries today.

Recent work has upgraded what had often been a crude and temporary system into one that families find acceptable, affordable and even desirable. There are many examples indicating that ownership of a modern pit system is seen socially as an achievement and this pride of ownership in turn leads to better standards of construction and maintenance.

In the search for effective, affordable and acceptable forms of pit latrine, BRE introduced a double-pit system (the permanent improved pit – PIP) to Botswana in 1979[2]. The PIP version of the pit latrine is a permanent installation, whose chambers require emptying periodically. In order to avoid any potential health hazard, the PIP system incorporates two chambers (pits). After some three years' use, one chamber is closed off and the second chamber is brought into service. After about two years' further retention, the sludge from the first chamber is removed, so that the chamber is ready for re-use before the second one becomes full. The retention period ensures that the sludge will be free of organisms harmful to health, as well as being much reduced in volume, owing to digestion and leaching of liquids to the ground.

Mechanised emptying

Since manual emptying of pit latrines is unacceptable in many developing countries, there is a need for mechanised emptying of not only the newer types of double pits, but also the many thousands of traditional single pits already in existence. There is an increasing requirement therefore for effective equipment, capable of desludging pits and tanks containing a wide range of sludges, varying not only in water content and organic material, but having different amounts of abrasive particles, stones and general rubbish commonly found in pit latrines.

Mechanical equipment used for desludging septic tanks is usually a suction tanker (cesspit emptier) utilising a 75 mm or 100 mm diameter flexible suction hose connected to a truck-mounted vacuum tank. Air is evacuated from this tank, producing a partial vacuum of around 0.8 bar (often a lot less owing to loss of efficiency of the vacuum pump). When the

Building Research Station
Garston
Watford WD2 7JR
Telephone: (Garston) 0923 674040
Telex: 923220

Fire Research Station
Borehamwood
Hertfordshire WD6 2BL
Telephone: 01-953 6177
Telex: 8951648

Princes Risborough Laboratory
Princes Risborough
Aylesbury
Buckinghamshire HP17 9PX
Telephone: Princes Risborough 3101
Telex: 83559

Building Research Establishment
Scottish Laboratory
Kelvin Road, East Kilbride
Glasgow G75 0RZ
Telephone

▲Technical enquiries to▲

suction hose is inserted through the scum and supernatant layers in the septic tank, sludge is drawn from near the bottom and deposited in the vacuum tank. The sludge is then transported to a local sewage treatment works for secondary treatment, or disposed to such as landfill.

Septic tank effluent and sludge, along with all types of untreated sewage and sewage sludge, are potential health hazards and polluters of the environment. Measures must always be taken to prevent casual access to these materials by people, animals and insects.

Pit latrine sludge

The contents of pit latrines, which are most likely to be located in the developing countries, are often called 'sludge'. Pit sludges are often very different from sewage and septic tank sludges, which have a very high water content and hardly any of the debris found in pit latrines. Pit latrines operate, more or less satisfactorily, over a wide range of loadings; the main variable is the amount of water present and also the presence of abrasive material, such as sand, soil and stones.

One of the few surveys to have been reported of pit contents describes what was found in pit latrines in the Gaborone area of Botswana and Dar es Salaam in Tanzania[3]. It was thought that these two locations had pit contents which were fairly representative of those in the developing world. The majority of samples taken during this survey had the following composition:

Water	average 55%
Sand	average 20%
Organics	average 25%

Relative densities ranged from 0.97 to 1.75, with a mean value of 1.36.

In addition to the above three major constituents, the survey found in half of the 50 or so pits examined, varying amounts of rubbish such as rags, bags, sacking, small pieces of wood, bricks and bottles.

Only a few of the samples, less than six months old, were found to contain more than 70 per cent water. All samples with less than 30 per cent sand were less than one year old.

Constraints on desludging pits and tanks

The following problems are amongst those to be considered in relation to methods and equipment for desludging pits and tanks in a developing country.

(a) Limited access to the house plot (perhaps no access road)

(b) Limited access to the chamber (inaccessible siting of chamber on plot, sometimes access only through house)

(c) Limited access to the chamber contents (sometimes access only through the inlet hole of a latrine, limited hole size and headroom)

(d) The nature of the chamber contents (sludge and other debris):
   i High resistance to flow (viscous composition)
   ii Highly abrasive nature of the sludge (high grit content in pit sludges)
   iii Presence of sticks and stones (sometimes used for anal cleansing)

(e) Flow problems of getting sludge from a pit or tank into a pump system (eg reciprocating pumps need to be self-priming)

(f) Shortage of skills to operate and maintain equipment (planned maintenance is essential for efficient utilisation of mechanical equipment)

(g) Social implications (reactions of householders to odour and general disturbance)

The main constraints on system selection are those of access and the abrasive nature of the sludge. The only system likely to be feasible is a suction system, employing a flexible hose of between 75 mm and 100 mm diameter. The capacity of the system would need to be such that any of the sludges likely to be found in pits and tanks in developing countries could be drawn. The suction system should be effective over horizontal distances of up to 50 m and vertical lifts of up to 6 m. This horizontal capability would facilitate drawing sludge where direct vehicular access to the chamber is not possible. The 6 m minimum head capacity is to allow for the depth of a chamber and the height of the vacuum tank above ground level.

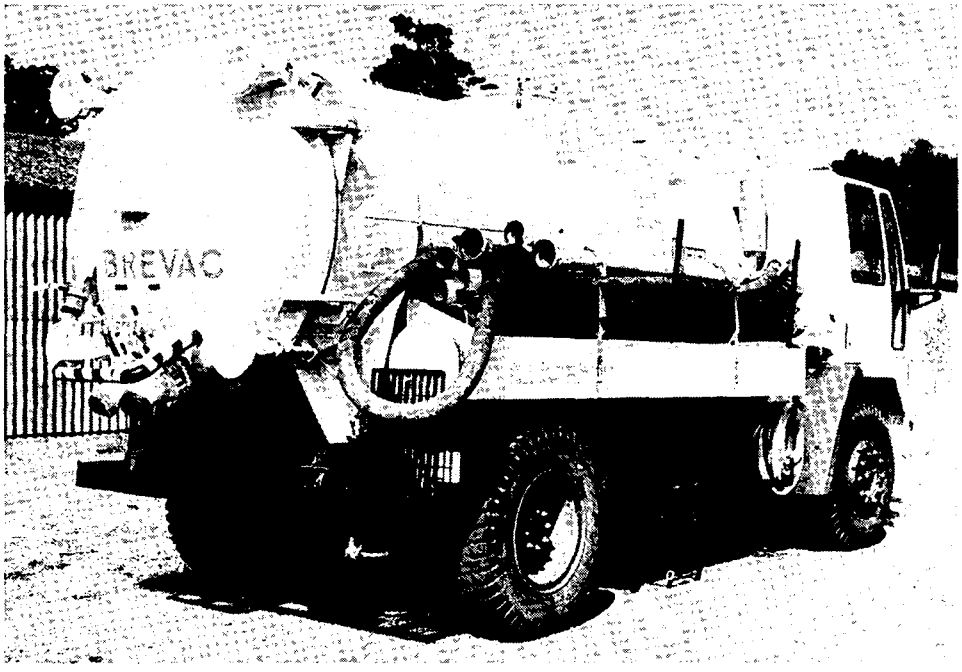
THE BREVAC SUCTION TANKER

Resulting from experimental work at BRE using simulated sludges and various suction systems, a specification was prepared for a suction tanker that would satisfy all of the constraints.

The resulting prototype tanker (see photographs) has been called BREVAC and was built for BRE by Airload Engineering Ltd of Pembroke Dock, Dyfed, for field trials in Africa; the company has now been granted a licence to manufacture the tanker.

The BREVAC suction system combines a partial vacuum effect with pneumatic conveying in order to draw a range of sludges, from water to heavy viscous sludge with 50 per cent solids content. Heavy sludges can be drawn over hose lengths up to 50 m and hose diameters of 75 mm or 100 mm can be used, according to access and flow-rate requirements. The tanker also has a washwater facility with storage tank and hose. The full tank can be emptied either by pressure discharge hose or by tipping the tank.

Proving trials were carried out in the United Kingdom, drawing simulated pit latrine contents, estuary silt, and waterworks and colliery sludge. Longer-term field trials are being conducted in



Botswana, where over 12 000 PIP-type latrines have been installed and where many traditional single-pit latrines require emptying to extend their useful life.

This versatile tanker is also capable of emptying settlement lagoons or sludge holding tanks. This has potential application in the United Kingdom and a wide range of countries.

More information about BREVAC can be obtained from the Overseas Development Research Unit at the Building Research Establishment.

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