An improved break-pressure tank for rural water supply

by James Narkevic

Here is a proven, novel, break-pressure tank for small-diameter piped water supplies in rural areas of developing countries. Its principal features include: the elimination of all valve boxes, a stilling chamber, and low-cost, quick, on-site construction.

IN DISTANT, RURAL communities, a good design for a drinking-water system can literally mean the difference between life and death. Common problems in the distribution systems of Andean, gravity-fed water supply projects are washer wear at house taps, wastage at use points, and leakage at vulnerable places such as fittings and joints, all a result of static water pressure. These problems can be eliminated by the judicious use of break-pressure devices.

The simplest solution is the installation of pressure-reduction valves. These valves are normally imported from industrialized countries exclusively for individual programmes or projects, and are therefore unavailable locally to small communities that may require replacement valves or additional valves for a water system extension. Although periodically sold in the largest cities, rural dwellers would find it hard to locate or afford these valves. Obviously the simplest solution is not necessarily the best solution in all countries.

A pressure-reduction valve is not simply a common gate or globe valve installed along a distribution line for water flow regulation. The use of a gate or globe valve in this way may provide pressure relief during peak-demand periods, but will provide no relief during zero-demand hours, usually between 10pm and 4am. Even a slightly open gate or globe valve will transmit full static pressures, assuming that the pipes are completely filled with water.

A better solution is a simple water break, such as that provided by a classic break-pressure tank (BPT) which maintains an unsubmerged inlet. Float valves attached to the inlet pipe maintain the water pressure for house connections above the tank. When there is no water demand from connections below the tank, the float valve closes and prevents water wastage.

Figure 1 shows an example of the BPT just described. Water enters the tank from the left and an air break is maintained between the water entering the unit and the water leaving the unit. The submerged outlet pipe is not visible here. The central chamber contains the float valve which consists of, from left to right, a plunger-seated valve, a leverage rod, and a buoy.

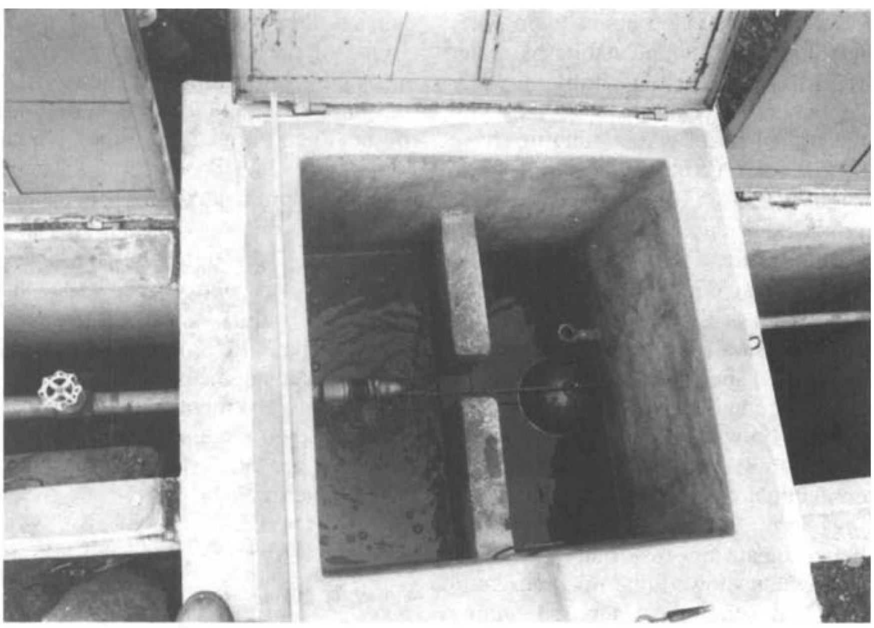


Figure 1. The classic BPT with unsubmerged inlet, costing about $US200.

Normally, an inlet valve (seen on the far left) is installed just before the float valve, in order to cut off water during repair of the float. Placing a control valve at the inlet instead of at the outlet ensures that when the valve is closed the inlet piping and distribution main will maintain some pressure throughout, thereby reducing any threat of contamination by water aspirated into empty piping. (An outlet valve, when closed, will create a partial vacuum in the piping as the water in the pipe rushes downhill and no more water can replace it. The same danger of aspirating contaminated water exists. Operators should be trained to recognize the importance of maintaining water in the distribution piping at all times.)

A second valve is often placed on a clean-out pipe for routine maintenance. When sediment accumulates at the bottom of the BPT, this valve can be opened to flush the tank. The pipe seen at right is the overflow, used to channel away water properly when the float valve is malfunctioning or absent.

Valves are often housed in concrete valve boxes, such as those in the photo on either side of the central chamber, to protect them from the elements or from tampering.

Total construction costs for the BPT shown in Figure 1, with 1in. inlet and outlet pipes and a 1.5in. clean-out and overflow, come to nearly $US200. (Prices vary between countries.) A project needing many BPTs underlines the necessity to find a less expensive alternative.

In fact, after years of experimentation, just such an alternative design has been tested and found suitable. Figure 2 provides a glimpse of the improved model, which incorporates the following features:

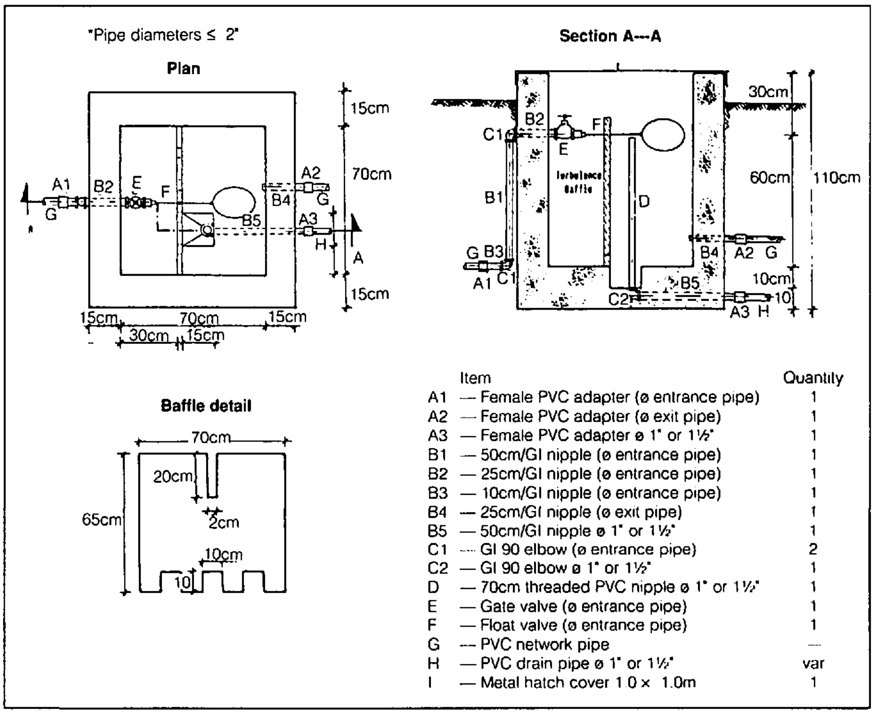
- Elimination of entrance and exit valve boxes;
- Elimination of the clean-out valve;
- A mid-chamber baffle which forms a stilling basin;
- Reduced construction time; and
- Reduced construction cost in both labour and materials.

Elimination of entrance and exit valve boxes The entrance valve is no longer placed outside the main BPT chamber, but inside, immediately before the float valve (see Figure 2). This effectively eliminates the need for an entrance valve box. The exit valve box, which housed the clean-out valve, has also been eliminated.

Elimination of the clean-out valve Periodic flushing of the improved BPT can be achieved by means of an outlet which functions both as the overflow and the clean-out. A galvanized-iron (GI) fitting can be embedded into the BPT floor and a drain pipe installed to conduct any wastewater away from the BPT into a adequate channel for removal (see Figure 3). The overflow riser-pipe may be of galvanized iron or, preferably, of thick-walled PVC pipe. (The PVC pipe cannot damage the threads of the embedded fitting. The riser can be threaded at both ends should one set of threads become stripped over time.) The clean-out valve is thus eliminated, and cleaning is performed by unscrewing the riser-pipe. Once the BPT chamber is washed and the threads of the embedded fitting are cleaned thoroughly of any deposits, the riser pipe is re-attached to function as the overflow. Teflon thread tape should always be applied to the riser-pipe, to improve watertightness and facilitate future riser-pipe removal.

A mid-chamber baffle A common problem encountered in BPTs is the failure of the float valve leverage rod. This breakage is largely a result of fatigue, caused by the continuous horizontal movement of the buoy. The buoy and leverage rod are designed to move vertically, not horizontally. Horizontal movement comes from the buoy reacting to the turbulent water conditions caused as the water jets in from the open float valve: the valve opens, water jets out, and the water surface moves wildly, causing the buoy and rod to move horizontally. The mid-chamber baffle practically eliminates surface water turbulence on the buoy side. (Compare the water surfaces on both sides of the baffle of Figure 2.) A slot in the baffle allows the rod to move vertically, and perforations at the bottom of the baffle permit water flow through to the outlet side.

Reduced construction time The improved BPT can be constructed in less than two working days by one mason and one helper. The older tanks required up to four days construction time because of the additional formwork, materials, and fittings employed. Tanks can be built of concrete, brick, or stone masonry, depending on local availability.



Item		Quantity
A1	— Female PVC adapter (ø entrance pipe)	1
A2	— Female PVC adapter (ø exit pipe)	1
A3	— Female PVC adapter ø 1" or 1½"	1
B1	— 50cm/GI nipple (ø entrance pipe)	1
B2	— 25cm/GI nipple (ø entrance pipe)	1
B3	— 10cm/GI nipple (ø entrance pipe)	1
B4	— 25cm/GI nipple (ø exit pipe)	1
B5	— 50cm/GI nipple ø 1" or 1½"	1
C1	— GI 90 elbow (ø entrance pipe)	2
C2	— GI 90 elbow ø 1" or 1½"	1
D	— 70cm threaded PVC nipple ø 1" or 1½"	1
E	— Gate valve (ø entrance pipe)	1
F	— Float valve (ø entrance pipe)	1
G	— PVC network pipe	—
H	— PVC drain pipe ø 1" or 1½"	var
I	— Metal hatch cover 1.0 × 1.0m	1

Figure 3. The break-pressure tank distribution network.

Reduced construction costs The improved BPT can be built for nearly $100 less than the standard model, considering the professional labour saved and the fewer materials employed. Additional savings include the cost of hand-carrying extra cement, sand, gravel, and rock to the worksite, especially in areas of limited access.

Limitations

The improved BPT is subject to certain limitations in order to function correctly. This BPT is for use with small-bore water distribution pipe, generally under 2in. in diameter. Larger pipe diameters may dictate the use of solutions not considered within the scope of this article. The maximum vertical drop between BPTs should be 50m. Experience has shown that vertical drops greater than 50m permit pressures that, over time, do not allow the float valve to seal completely. The highest quality float valve on the local market should be used, as poorly constructed valves deteriorate rapidly under the continuous working conditions found in small diameter systems. The water should not contain excessive quantities of sand or silt which can jam the float mechanism, overwhelm the clean-out pipe capacity, and require continuous BPT cleaning. ●

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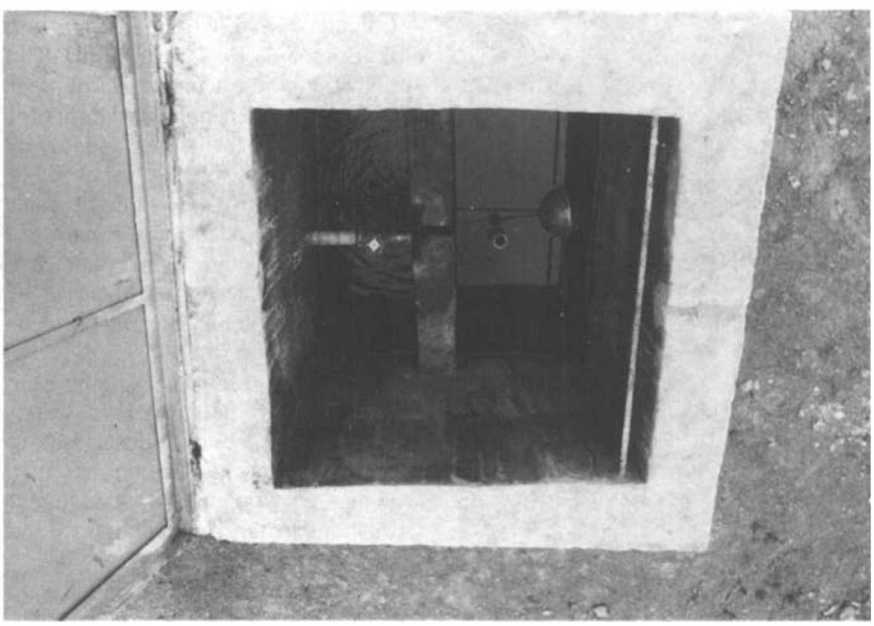

Figure 2. An alternative BPT design which is faster and cheaper to build.