# NOTES

## A SIMPLE PUMP FOR EXTRACTING WATER FROM NEUTRON ACCESS TUBES AND MINI-RHIZOTRONS

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### Abstract

**Water in neutron-probe access tubes and mini-rhizotrons impedes the acquisition of accurate data under wet field conditions. When such situations arise, water must be extracted before data can be taken. The objective was to design, construct, and use a pump that would be easy to operate, portable, and inexpensive. The pump was found to be a useful tool for extracting undesired water from access tubes and mini-rhizotrons. Only one to three strokes of the pump were necessary to remove all but about 0.05 to 0.1 L of water from a 2.5-m-long neutron access tube that was completely filled with water. The pump, which is easily constructed with materials available at any hardware store, proved to be an easy-to-use and cost-effective tool for field use.**


*Additional Index Words:* **Residual water, Data acquisition, Root observation tube.**

THE PRESENCE of water in neutron-probe access tubes and mini-rhizotrons has long been a source of aggravation for researchers and irrigation consultants. Because of the difficulty in maintaining waterproof seals over extended periods of time, tubes frequently accumulate large quantities of water. Heavy spring rains, perched water tables, and general low spots in the field can all lead to accumulation of water in access tubes via unsealed ends (Eeles, 1969; Bohm, 1974) or spliced extensions (Glenn et al., 1980; Howse, 1981). Under these circumstances it is necessary to remove the water from the tubes before taking neutron or root measurements. Numerous methods have been devised to deal with this problem, e.g., electric pumps, air pressure, hand-operated oil pumps, and wet-dry vacuum cleaners. None of these devices has proven to be completely satisfactory for use in the field. The pump described herein was devised to provide a portable, lightweight, and inexpensive method of extracting water from neutron-probe access tubes and from mini-rhizotron root observation tubes.

### Materials and Methods

A simple pump for 50.8-mm o.d. (47.9-mm i.d.) neutron access tubes was fabricated from materials purchased at a local hardware store (Fig. 1). The list of materials included one steel pipe 3 m long by 6.35-mm i.d. (1/4-in.); one galvanized tee, 6.35-mm i.d. (1/4-in.); one piece of cold rolled-steel round stock 6.35 mm long by 50.8-mm diam. (1/4- by 2-in.); one piece of neoprene gasket material 300 by 300 by 8 mm thick; one galvanized pipe nut, 6.35-mm i.d. (1/4-in.); and one flat washer, 25.4-mm o.d. (1-in.).

Skilled labor was required to fabricate the plunger part of the pump (Fig. 1), which was machined to a diameter of about 46 mm. The clearance between the plunger and the neutron access tube wall was about 2 to 3 mm. A center hole was drilled and tapped to accept the steel pipe. Other holes, about 6.35 mm in diameter, were drilled through the plunger to allow water or mud slurry, or both, which are sometimes found in the bottom of neutron tubes, to pass through on the downstroke of the pump. The steel pipe was cut to a length of 2.7 m and the remaining pipe was used to make a tee handle. Neoprene gasket material was cut to the correct diameter using a punch fashioned from a small length of 50.8-mm steel mechanical tubing (used for neutron access tubes) sharpened on one end. Several diaphragms were punched from the gasket material and saved as spares. The neoprene diaphram, flat washer, and pipe nut were arranged as in Fig. 1, and the plunger was then screwed onto the pipe and tightened against the nut.

### Results and Discussion

A schematic drawing of the pump action in extracting water from a neutron access tube is shown in Fig. 2. Some of the water will exit through the pipe via the tee handles on the downstroke. The amount exiting through the handles depends on the force used; the harder the downstroke, the greater the amount of water that will exit the handles. Some of the water will pass through the plunger and diaphragm on the downstroke; this amount also depends on the force exerted. On the upstroke, the pump lifts water that has passed through the plunger and diaphragm out of the tube. At the same time, air enters through the tee handles so that no vacuum develops within the neutron access tube. Experience with this pump in the field shows that only one to three pump strokes are necessary to remove all but a small amount of residual water from

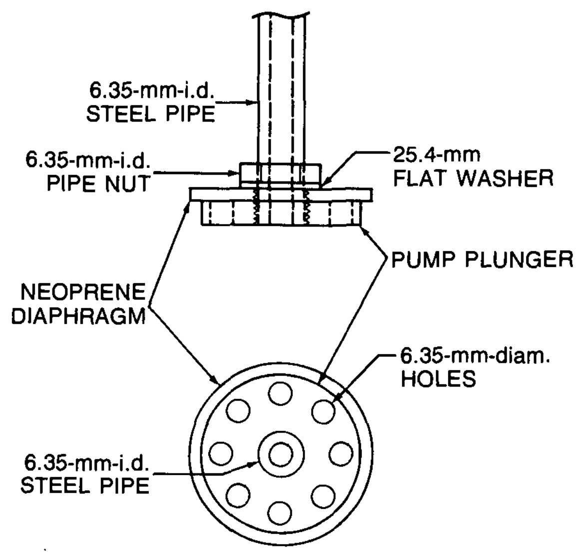


**Fig. 1. Plan and side view of the pump plunger and diaphragm construction.**

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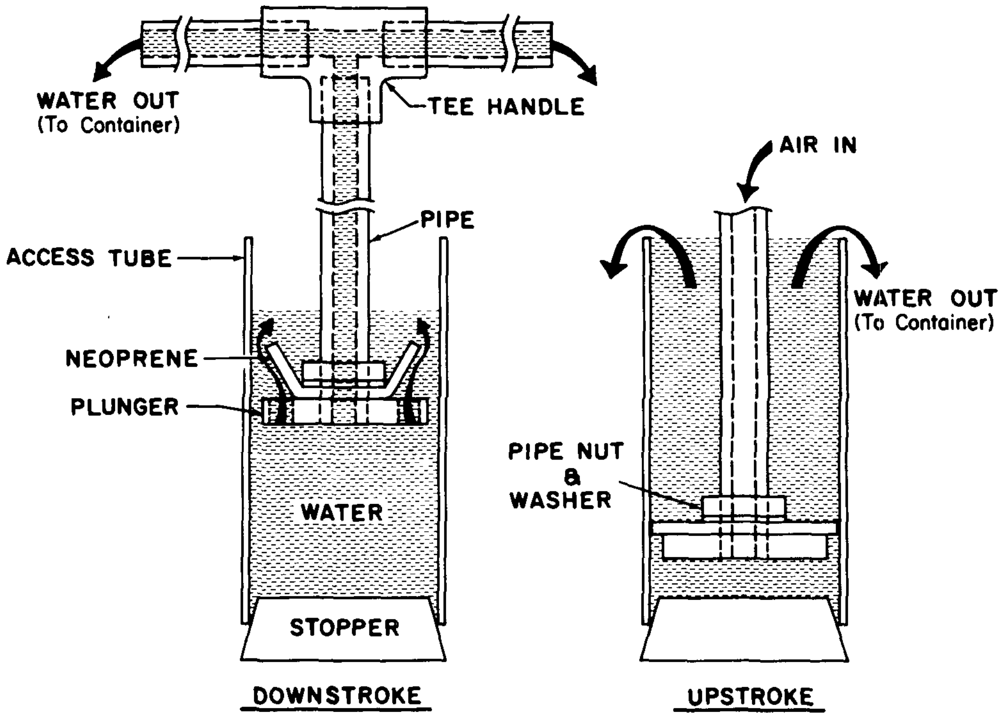


**Fig. 2. Schematic diagram of the pump action.**

a completely filled 50.8-mm o.d. by 2.5-m-deep neutron access tube. The force required to operate the pump is about the same as that required to operate a bicycle tire pump.

One of the problems with the pump, like previous methods, is that a small amount of residual water (approximately 0.05–0.1 L) usually remains in the tube after pumping. This water can easily be removed with a sponge mounted on the end of a long handle (a 50- by 50- by 150-mm cellulose sponge holds approximately 0.07 L). Under wet field conditions, for which it was designed, the pump was used to empty 20 neutron access tubes of mud and water. The tubes were 2.5 m deep and about two-thirds full. The sponge was used to soak up the residual water left by the pump. The entire process took about 1 h. Another disadvantage of using the pump is that the water extracted from the access tube is *dumped* on the soil surface around the tube. One way to eliminate this problem for water removed during the downstroke is to attach plastic or other tubing to the handles to route the water to a container. One method to reduce the effect of water extracted during the upstroke on subsequent neutron measurements is to place a sheet of plastic around the access tube. Another method would be to place an angel-food cake pan over the access tube to catch the water removed with the upstroke of the pump. An additional method, which requires a simple modification to the design illustrated in Fig. 1, would be to reverse the positions of the plunger and the neoprene. This modification would eliminate the action of the upstroke and water would be forced up the center pipe, out the handles, and routed via tubing to an appropriate container. This modification has been tried and was found to be successful. Fortunately, the amount of water involved is usually small compared to the soil water holding capacity, thus making the discarding problem less of a practical issue.

The pump can easily be adapted to different tube diameters. We also successfully removed water from 010.2-cm o.d. mini-rhizotrons installed in the field.

The pump, which has been used for approximately 3 yr, was found to be easier to use, less time consuming, and less expensive than other more sophisticated methods. An additional advantage is that this device requires no electrical power.

## References

Bohm, W. 1974. Mini-rhizotrons for root observations under field conditions. Z. Acker-Pflanzenbau. 140:282–287.

Eeles, C.W.O. 1969. Installation of access tubes and calibration of neutron probes. Institute of Hydrology Rep. 6. Wallingford, England.

Glenn, D.M., R.L. Henderson, and F.E. Bolton. 1980. A retractable, neutron-probe access tube. Agron. J. 72:1067–1068.

Howse, K.R. 1981. A technique for using permanent neutron meter access tubes in cultivated soils. Exp. Agric. 17:265–269.