Analysis and Evaluation of Pumping Test Data

Second Edition (Completely Revised)

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Contents

because flow in the (saturated) capillary fringe above the watertable is neglected (Van der Kamp 1985).

Under favourable conditions, the early and late-time drawdown data can also be analyzed by the methods given in Section 3.2. For example, the Theis method can be applied to the early-time segment of the time-drawdown curve, provided that data from piezometers near the well are used because the drawdown in distant piezometers during this period will often be too small to be measured. The storativity S_A computed from this segment of the curve, however, cannot be used to predict long-term drawdowns. The late-time segment of the curve may again conform closely to the Theis type curve, thus enabling the late-time drawdown data to be analyzed by the Theis equation and yielding the transmissivity and the specific yield S_Y of the aquifer. The Theis method yields a fairly realistic value of S_Y (Van der Kamp 1985).

If a pumped unconfined aquifer does not show phenomena of delayed watertable response, the time-drawdown curve only follows the late-time segment of the S-shaped curve. Because the flow pattern around the well is identical to that in a confined aquifer, the methods in Section 3.2 can be used.

True steady-state flow cannot be reached in a pumped unconfined aquifer of infinite areal extent. Nevertheless, the drawdown differences will gradually diminish with time and will eventually become negligibly small. Under these transient steady-state conditions we can use the Thiem-Dupuit method (Section 5.2).

The methods presented in this chapter are all based on the following assumptions and conditions:

- The aquifer is unconfined;
- The aquifer has a seemingly infinite areal extent;
- The aquifer is homogeneous and of uniform thickness over the area influenced by the test;
- Prior to pumping, the watertable is horizontal over the area that will be influenced by the test;
- The aquifer is pumped at a constant discharge rate;
- The well penetrates the entire aquifer and thus receives water from the entire saturated thickness of the aquifer.

In practice, the effect of flow in the unsaturated zone on the delayed watertable response can be neglected (Cooley and Case 1973; Kroszynski and Dagan 1975). According to Bouwer and Rice (1978), air entry phenomena may influence the drawdown.

Although the aquifer is assumed to be of uniform thickness, this condition is not met if the drawdown is large compared with the aquifer's original saturated thickness. A corrected value for the observed drawdown s then has to be applied. Jacob (1944) proposed the following correction

$$s' = s - (s^2/2D)$$

where

s' = corrected drawdown
s = observed drawdown
D = original saturated aquifer thickness