5.11.1

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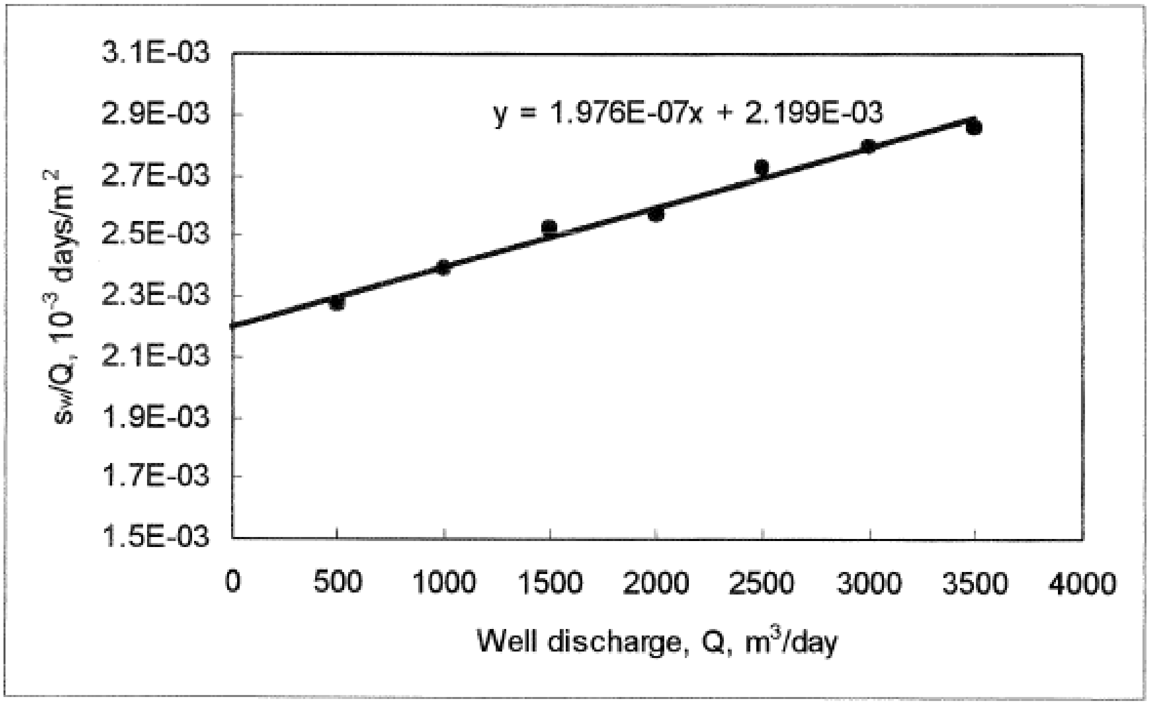
5.11.1 (a) Using the given time-drawdown data s_w/Q versus Q is plotted as shown in the following figure . Then, a straight line is fitted through the data points.



The equation for the best-fit straight line is given by

$$y = 1.976 \times 10^{-7} x + 0.002199$$

or

$$\frac{s_w}{Q} = 1.976 \times 10^{-7} Q + 0.002199$$

Thus, from equation 5.11.4 the formation loss coefficient is $B = 0.002199\ days/m^2$ and the well loss coefficient is $C = 1.976 \times 10^{-7}\ day^2/m^5$ or $C = 0.41 \min^2/m^5$.

(b) Using the $B = 0.002199\ days/m^2$ and $C = 1.976 \times 10^{-7}\ day^2/m^5$ coefficients, calculate the theoretical drawdowns for the discharges given in the problem statement:

Q (m^3/day)	BQ (m)	CQ^2 (m)	Theoretical s_w (m)	Actual s_w (m)	$\lvert\Delta s_w\rvert$ (m)
500	1.10	0.05	1.15	1.14	0.01
1000	2.20	0.20	2.40	2.39	0.01
1500	3.30	0.44	3.74	3.79	0.05
2000	4.40	0.79	5.19	5.15	0.04
2500	5.50	1.24	6.73	6.81	0.08
3000	6.60	1.78	8.38	8.4	0.02
3500	7.70	2.42	10.12	10.02	0.10

As shown in the table above, $n = 2$ assumption yields theoretical drawdown estimates within 10 cm of the actual drawdowns. This is acceptable in most practical situations.

Since $C = 0.41 \min^2/m^5$ from part (a), it can be said the pumping well is properly designed and developed according to Walton's criteria.

(c) For a pumping rate of $Q = 1250\ m^3/day$,

$$\begin{aligned} s_w &= BQ + CQ^2 \\ &= (0.002199\ days/m^2)(1250\ m^3/day) + (1.976\times10^{-7}\ day^2/m^5)(1250\ m^3/day)^2 \\ &= 3.0575\ m \end{aligned}$$

Thus, the specific capacity is given by

$$\frac{Q}{s_w} = \frac{1250\ m^3/day}{3.0575\ m} \cong 409\ m^3/day/m$$

and the efficiency of the well can be computed using equation 5.12.4

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{409\ m^2/day}{1/(0.002199\ day/m^2)} = 90\%$$

5.14.3

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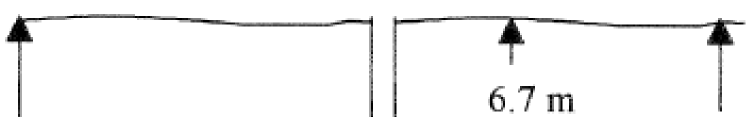
5.14.3 slug test by Hvorslev method

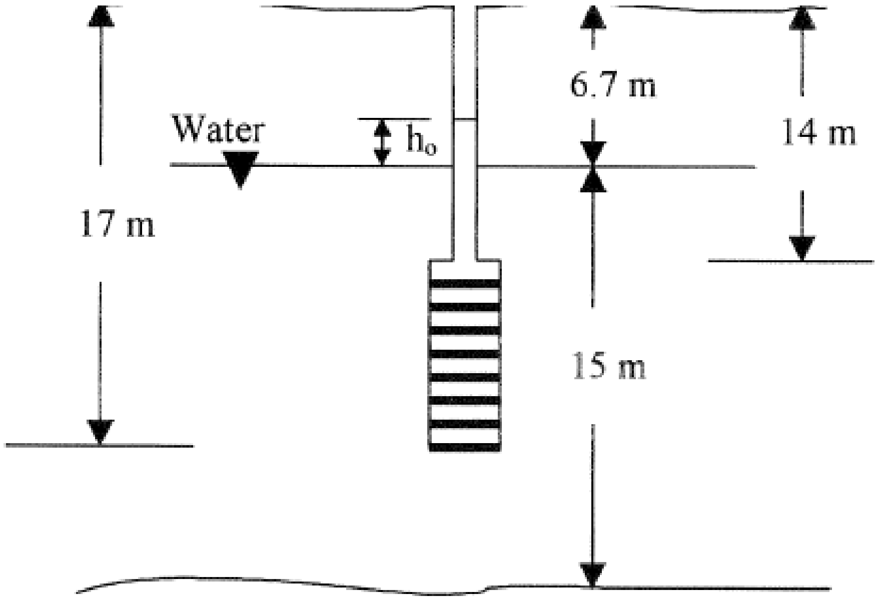
t, s	change, m
0	0.64
1	0.617
2	0.491
3	0.433
4	0.385
5	0.34
6	0.305
7	0.268
8	0.241
9	0.211
10	0.189
11	0.169
12	0.147
13	0.13
14	0.115
15	0.101
16	0.089
17	0.078
18	0.068
20	0.051
22	0.038
23	0.032

Boring diameter 20 cm
casing diameter 5.1 cm
Bottom of well 17 m BGS
Depth top casing 14 m BGS
Depth to water 6.7 m BGS
Saturated thickness 15 m

5.13.5 A conceptual picture of the problem is depicted below. From this picture and the given well construction information:

$$r_c = 2.55\ cm, \quad r_w = 10\ cm, \quad L_e = 3\ m, \quad L_w = 10.3\ m, \quad h = 15\ m$$





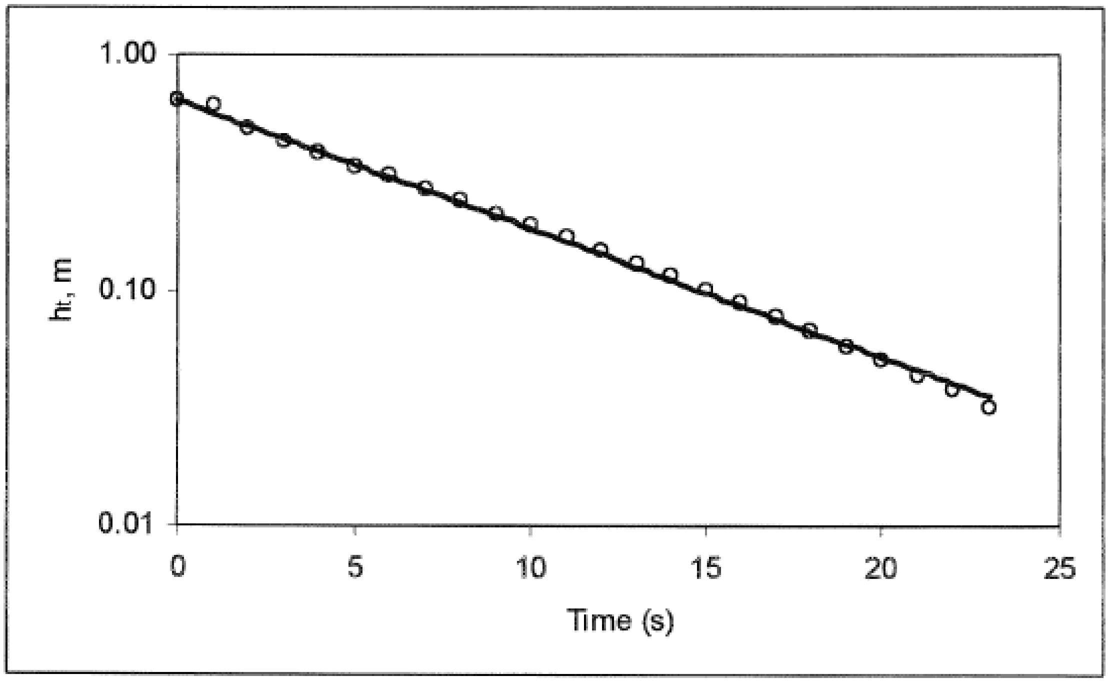
Since L_w is less than h, the saturated thickness of the aquifer, Eq. 5.13.10 must be used.

$$\ln\frac{R_e}{r_w}=\left[\frac{1.1}{\ln(L_w/r_w)}+\frac{A+B\ln[(H-L_w)/r_w]}{L_e/r_w}\right]^{-1}$$

$$L_e/r_w = 300\ cm/10\ cm = 30 \quad \rightarrow Fig.\ 5.13.6 \rightarrow A = 2.5\ and\ B = 0.4$$

$$\ln\frac{R_e}{r_w}=\left[\frac{1.1}{\ln(1030\ cm/10\ cm)}+\frac{2.5+(0.4)\ln[(1500\ cm-1030\ cm)/10\ cm]}{300\ cm/10\ cm}\right]^{-1}=2.688$$

A plot of the response data on semilogarithmic scale is shown below.



From this plot, the time T_0 for $h_t = 0.368h_0$ is 7.95 s. Substituting these into Eq. 5.13.9

$$K=\frac{r_c^2\ln(R_e/r_w)}{2L_e}\frac{1}{t}\ln\left[\frac{H_0}{H_t}\right]=\frac{r_c^2\ln(R_e/r_w)}{2L_e}\frac{1}{T_0}\ln\left[\frac{H_0}{0.368H_0}\right]=\frac{r_c^2\ln(R_e/r_w)}{2L_e}\frac{1}{T_0}$$

$$K=\frac{(2.55\ cm)^2(2.688)}{(2)(300\ cm)}\frac{1}{(7.95\ s)}=0.00366\ cm/s=3.17\ m/day$$

The K value found using Hvorslev method was 4.03 *m/day*. Thus, both methods yield similar rcsults.

5.15.1

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Repeat 5.14.3 using Bouwer and Rice method