

Applied Hydrogeology | (4th Edition)

Chapter 5, Problem 17P

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Problem

Answers to odd-numbered problems appear at the end of the book. Type curves will be necessary for the solution of many of these problems. Type curves can be constructed from the data in the appendices, although this process is laborious. Type curves have been published for a number of aquifer tests on confined aquifers. The curves were derived by, among others, the Theis method, the two methods for leaky artesian aquifers given in this chapter, and the Cooper-Bredehoeft-Papadopoulos method. (J. E. Reed, "Type Curves for Selected Problems of Flow to Wells in Confined Aquifers," in *Techniques of Water-Resources Investigations of the United States Geological Survey*, Book 3, Chapter B3, 1980. This is available from the U.S. Government Printing Office, Washington, D.C., or Scientific Publications Company, P.O. Box 23041, Washington, D.C. 20026-3041.) The published type curves use 3 × 5 cycle logarithmic graph paper with 1.85 in. for each log cycle, such as Keuffel and Esser Co. 46 7522, and semilogarithmic graph paper with 2.00 in. per log cycle, such as Keuffel and Esser Co. 46 6213. The Jacob straight-line methods will require fourcycle semilogarithmic paper such as Keuffel and Esser Co. 46 6013. Instructors may request a copy of the solution manual for *Applied Hydrogeology* from their Prentice-Hall representative. Type curves for these problems are contained therein.

A test well was drilled to a total depth of 117 ft with the following geologist's log:

0-73 ft	Coarse sand
73-82 ft	Clayey sand
82-117 ft	Coarse sand
117 ft	Crystalline bedrock

The depth to water was 55 ft. The test well was screened from 82 to 117 ft. It was pumped at a rate of 560 gal/min. Drawdown was measured in an observation well that was also screened from 82 to 117 ft and was located 82 ft away from the pumping well. The following time-drawdown data were obtained:

Elapsed Time (min)	Drawdown (ft)
0	0.00
1	0.90
2	2.15
3	3.05
4	3.64
5	4.07
6	4.52
7	4.74
8	5.02
9	5.21
10	5.53
15	5.72
20	5.97
30	6.12
40	6.20
50	6.25
60	6.27
90	6.29
120	6.29

(A) Plot the time-drawdown data on 3 × 5 cycle logarithmic paper. Compute the value of the storativity and transmissivity of the aquifer using the graphical method for leaky aquifers. Find the vertical hydraulic conductivity of the confining layer.

(B) Compute the value of aquifer storativity and transmissivity of the aquifer using the Hantush infection-point method.

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Step-by-step solution

Step 1 of 11

A)

Plot the time-drawdown curve matched with type curve as in Figure (1).

From Figure (1),

The match point values are,

The well function $W\left(u, \frac{r}{B}\right)$ is 1.

The parameter $\left(\frac{1}{u}\right)$ is 10.

The Boltzman variable (u) is 0.1.

The drawdown $(h_0 - h)$ is 3 ft.

The elapsed time (t) is 6.5 min.

The parameter $\left(\frac{r}{B}\right)$ is 0.4.

Comment

Step 2 of 11

Determine the aquifer transmissivity (T) using the relation;

$$h_0 - h = \frac{Q}{4\pi T} W\left(u, \frac{r}{B}\right)$$

Here, Q is pumping rate.

Substitute 560 gal/min for Q , 3 ft for $(h_0 - h)$, and 1 for $W\left(u, \frac{r}{B}\right)$.

$$3 = \frac{(560 \text{ gal/min} \times 0.1337) \text{ ft}^3/\text{min}}{4\pi \times T} \times 1$$
$$T = \frac{(560 \text{ gal/min} \times 0.1337) \text{ ft}^3/\text{min}}{4\pi \times 3}$$
$$= 1.986 \text{ ft}^2/\text{min}$$

Comment

Step 3 of 11

Determine the storativity of the aquifer (S) using the relation;

$$S = \frac{4Tut}{r^2}$$

Here, r is radial distance from the pumping well.

Substitute $1.986 \text{ ft}^2/\text{min}$ for T , 0.1 for u , 6.5 min for t , and 82 ft for r .

$$S = \frac{4 \times 1.986 \text{ ft}^2/\text{min} \times 0.1 \times 6.5}{82^2}$$
$$= 7.68 \times 10^{-4}$$

Comment

Step 4 of 11

Determine the thickness of aquitard (b') using the relation;

$$b' = \frac{r - H}{2} + \left(\frac{h_0 - h}{2}\right)$$

Here, H is depth of water.

Substitute 82 ft for r , 55 ft for H , and 3 ft for $(h_0 - h)$.

$$b' = \frac{82 - 55}{2} + \left(\frac{3}{2}\right)$$
$$= 15 \text{ ft}$$

Comment

Step 5 of 11

Determine the vertical hydraulic conductivity of the confining aquifer K' using the relation;

$$K' = \frac{Tb\left(\frac{r}{B}\right)^2}{r^2}$$

Here, b' is thickness of aquitard.

Substitute $1.986 \text{ ft}^2/\text{min}$ for T , 15 ft for b' , 0.4 for $\left(\frac{r}{B}\right)$, and 82 ft for r .

$$K' = \frac{1.986 \times 15 \times (0.4)^2}{82^2}$$
$$= 7.2 \times 10^{-4} \text{ ft/min}$$

Therefore, the vertical hydraulic conductivity of the confining aquifer is $7.2 \times 10^{-4} \text{ ft/min}$.

Comment

Step 6 of 11

B)

Plot the time-drawdown curve using Hantush infection point method as in Figure (2).

From Figure (2),

The maximum drawdown $(h_0 - h)_{\text{max}}$ is 6.3 ft.

The drawdown at the infection point $(h_0 - h)$ is 3.15 ft.

The time (t_i) is 3.2 min.

The slope of the drawdown curve at the infection point (m_i) is 4.65 ft.

Comment

Step 7 of 11

Determine the parameter $f\left(\frac{r}{B}\right)$ using the relation;

$$f\left(\frac{r}{B}\right) = \frac{2.3(h_0 - h)}{m_i}$$

Substitute 3.15 ft for $(h_0 - h)$, and 4.65 ft for m_i .

$$f\left(\frac{r}{B}\right) = \frac{2.3 \times 3.15}{4.65}$$
$$= 1.55$$

The parameter $f\left(\frac{r}{B}\right)$ is equal to the parameter $[\exp(x)K_0(x)]$. Therefore, the parameter $[\exp(x)K_0(x)]$ is 1.55.

Comment

Step 8 of 11

Find the parameter $\left(\frac{r}{B}\right)$ and $K_0\left(\frac{r}{B}\right)$.

Refer Appendix 5, "Values of the functions $K_0(x)$ and $\exp(x)K_0(x)$ " in the textbook.

For 1.55 for $\exp(x)K_0(x)$.

The parameter $\left(\frac{r}{B}\right)$ is 0.47.

The parameter $K_0\left(\frac{r}{B}\right)$ is 0.95.

Comment

Step 9 of 11

Determine the leakage factor (B) using the relation;

$$\frac{r}{B} = 0.47$$

Substitute 82 ft for r .

$$\frac{82}{B} = 0.47$$
$$B = \frac{82}{0.47}$$
$$B = 174.46 \text{ ft}$$

Comment

Step 10 of 11

Determine the aquifer transmissivity (T) using the relation;

$$T = \frac{QK_0\left(\frac{r}{B}\right)}{2\pi(h_0 - h)_{\text{max}}}$$

Substitute 560 gal/min for Q , 0.95 for $K_0\left(\frac{r}{B}\right)$, and 6.3 ft for $(h_0 - h)_{\text{max}}$.

$$T = \frac{(560 \text{ gal/min} \times 0.1337) \text{ ft}^3/\text{min} \times 0.95}{2\pi \times 6.3}$$
$$= \frac{72.1}{39.58}$$
$$= 1.82 \text{ ft}^2/\text{min}$$

Therefore, the aquifer transmissivity is $1.82 \text{ ft}^2/\text{min}$.

Comment

Step 11 of 11

Determine the storativity of the aquifer (S) using the relation;

$$S = \frac{4rT}{2\pi B}$$

Substitute 3.2 min for t_i , $1.82 \text{ ft}^2/\text{min}$ for T , 82 ft for r , and 174.46 ft for B .

$$S = \frac{4 \times 3.2 \times 1.82}{2\pi \times 82 \times 174.46}$$
$$= 0.0008$$

Therefore, the storativity of the aquifer is 0.0008 .

Comment

Was this solution helpful?

Recommended solutions for you in Chapter 5

Chapter 5, Problem 13P

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