Example 3.3 DETERMINATION OF T AND S BY THE THEIS METHOD

A fully penetrating well in a 25 m thick confined aquifer is pumped at a rate of 0.2 m^3/s for 1000 min. Drawdown is recorded vs. time at an observation well located 100 m away. Compute the transmissivity and storativity using the Theis method.

Solution. A plot of s' vs. r^2/t is made on log-log paper. This is superimposed on a plot of W(u) versus u, which is also on log-log paper. A point is chosen at some convenient point on the matched curve, and values for s', r^2/t, W(u) and u are read (see Figure 3.7 and the accompanying Tables 3.1 and 3.2).

TABLE 3.1 Radial flow to a well penetrating an extensive confined aquifer

Time (min)	s' (m)	Time (min)	s' (m)	Time (min)	s' (m)
1	0.11	20	0.71	90	1.11
2	0.20	30	0.82	100	1.15
3	0.28	40	0.85	200	1.35
4	0.34	50	0.92	400	1.55
6	0.44	60	1.02	600	1.61
8	0.50	70	1.05	800	1.75
10	0.54	80	1.08	1000	1.80

From the plot,

$$r^2/t = 180 \text{ m}^2/\text{min}$$
$$s' = 1.0 \text{ m}$$
$$u = 0.01$$
$$W(u) = 4.0$$

Equation (3.17) gives

$$s' = \frac{Q}{4\pi T} W(u)$$

$$T = \frac{Q\,W(u)}{4\pi s'}$$

$$T = \frac{(0.2\text{m}^3/\text{sec})(4.0)}{(4\pi)(1.0\text{m})}$$

$$\boxed{T = 6.37 \times 10^{-2} \text{m}^2/\text{sec}}$$

Equation (3.18) gives

$$\frac{r^2}{t} = \frac{4Tu}{S}$$

$$S = \frac{4Tu}{r^2/t}$$

$$= \frac{(4)(6.37\times 10^{-2}\text{m}^2/\text{sec})(0.01)}{(180\text{m}^2/\text{min})(1\text{ min}/60\text{ sec})}$$

$$\boxed{S = 8.49 \times 10^{-4}}$$

Source: Ground Water Contamination, Bedient et al., 1997.

TABLE 3.2 Calculated values for the Well function

u	W(u)	u	W(u)	u	W(u)	u	W(u)	u	W(u)
1 e-10	22.45	2 e-08	17.15	3 e-06	12.14	4 e-04	7.25	5 e-02	2.47
2	21.76	3	16.74	4	11.85	5	7.02	6	2.3
3	21.35	4	16.46	5	11.63	6	6.84	7	2.15
4	21.06	5	16.23	6	11.45	7	6.69	8	2.03
5	20.84	6	16.05	7	11.29	8	6.55	9	1.92
6	20.66	7	15.9	8	11.16	9	6.44	1 e-01	1.823
7	20.5	8	15.76	9	11.04	1 e-03	6.33	2	1.223
8	20.37	9	15.65	1 e-05	10.94	2	5.64	3	0.906
9	20.25	1 e-07	15.54	2	10.24	3	5.23	4	0.702
1 e-09	20.15	2	14.85	3	9.84	4	4.95	5	0.56
2	19.45	3	14.44	4	9.55	5	4.73	6	0.454
3	19.05	4	14.15	5	9.33	6	4.54	7	0.374
4	18.76	5	13.93	6	9.14	7	4.39	8	0.311
5	18.54	6	13.75	7	8.99	8	4.26	9	0.26
6	18.35	7	13.6	8	8.86	9	4.14	1 e+00	0.219
7	18.2	8	13.46	9	8.74	1 e-02	4.04	2	0.049
8	18.07	9	13.34	1 e-04	8.63	2	3.35	3	0.013
9	17.95	1 e-06	13.24	2	7.94	3	2.96	4	0.004
1 e-08	17.84	2	12.55	3	7.53	4	2.68	5	0.001

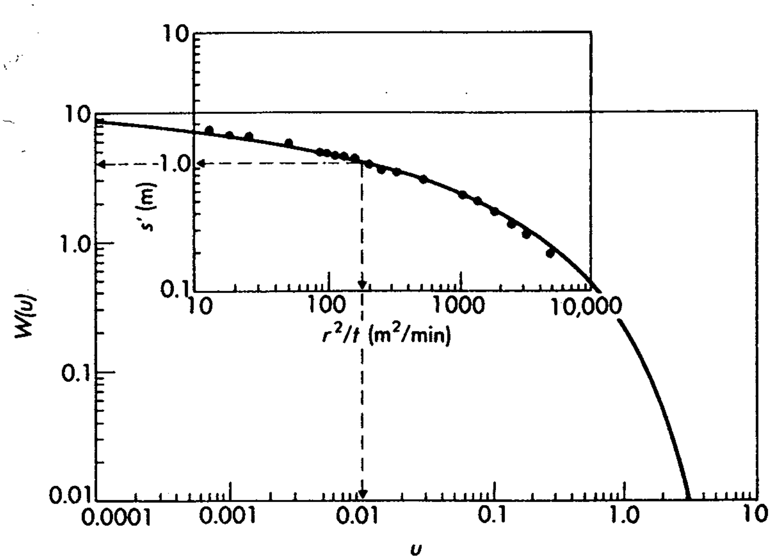

Figure 3.7 Theis curve compared to measured data.

Example 3.4 DETERMINATION OF T AND S BY THE COOPER-JACOB METHOD

Using the data given in Example 3.3, determine the transmissivity and storativity of the 25 m thick confined aquifer using the Cooper-Jacob method.

Solution. Values of s' and t are plotted on semilog paper with the t-axis logarithmic (see Figure 3.4). A line is fitted through the later time periods and is projected back to a point where $s' = 0$. This point determines t_0. $\Delta s'$ is measured over one log cycle of t.

From the plot,

$$t_0 = 1.6 \text{ min}$$
$$\Delta s' = 0.65 \text{ m}$$

Equation (3.23) gives

$$T = \frac{2.3Q}{4\pi\Delta s'}$$
$$= \frac{(2.3)(0.2\text{m}^3/\text{sec})}{(4\pi)(0.65\text{m})}$$

$$\boxed{T = 5.63 \times 10^{-2}\,\text{m}^2/\text{sec}}$$

Equation (3.22) gives

$$S = \frac{2.25Tt_0}{r^2}$$
$$= \frac{(2.25)(5.63 \times 10^{-2}\,\text{m}^2/\text{sec})(1.6\text{min})(60\text{sec}/1\text{min})}{(100\text{ m})^2}$$

$$\boxed{S = 1.22 \times 10^{-3}}$$