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DETERMINATION OF TRANSMISSIVITY AND STORAGE COEFFICIENT OF AQUIFERS BY THEIS METHOD AS AN EFFECTIVE TECHNIQUE

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Ground-water is an important source of water supply throughout the world. Transmissivity and Storage Coefficient are two important parameters in ground-water problems. Theis technique was used for the determination of these parameters. For this purpose data of 15 pumping wells were analysed and it was concluded that Theis technique was the best method for this purpose especially when the pumping wells were fully penetrating.

INTRODUCTION

Transmissivity (T) and storage coefficient (S) of an aquifer are of fundamental importance in ground-water problems. Information about the quantity of water which could effectively be stored and transmitted by an aquifer can be obtained by transmissivity and storage coefficient. This information may be used as guidelines in installation of tubewells for irrigation, drainage, industrial and municipal supply schemes. In Pakistan, ground-water contribution towards the total demand of the country is not much appreciated. Therefore, an extensive development of ground-water supplies by means of pumping wells is highly desirable in order to meet the increased demand of this essential article of daily use.

There were several methods available for the determination of transmissivity and storage coefficient, but the selection of a proper method could facilitate an economical and reliable estimate of the parameters. Theis (1935) developed a non-equilibrium well formula for the calculation of T & S. This formula took into account the effect of time of pumping on well yield. Cooper and Jacob (1946) presented a modified non-equilibrium formula which was valid only for which "U" $\leq$ 0.05, where U is an integral argument. Chow (1952) developed a method of solution with the advantage of avoiding curve fitting and certain limitations. Todd (1980) reported that T & S could best be determined from pumping test of wells or from ground-water fluctuations in response to atmospheric pressure or ocean's tide variations. Linsley *et al.* (1982) quoted use of "Dupuit" equation for the determination of T which was obtained from the equilibrium hydraulics of wells.

MATERIALS AND METHODS

In this study, Theis method was used for determination of T & S. For this purpose, the data of 15 pumping tubewells were obtained from WASA (Water and Sanitation Agency), Faisalabad, which were installed at different locations in Faisalabad region. Of these, only five representative pumping tubewells have been discussed here. The analysis of data involved the following steps:

i. A type curve was plotted taking W(u) & 1/U along the vertical and horizontal axes respectively on a log-log scale (see Fig. 1).

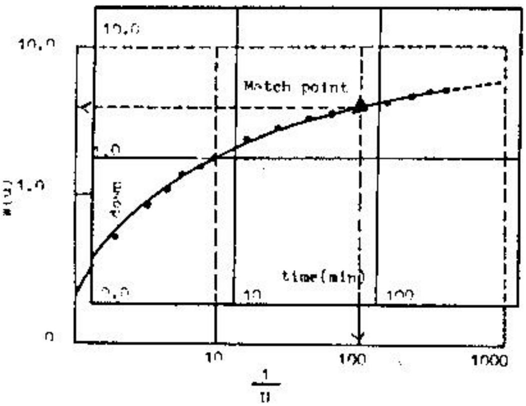

Fig. 1. Pumping test data curve superimposed on type curve.

ii. A time-drawdown curve was plotted on a log-log scale taking time (min.) and drawdown (d) on the horizontal and vertical axes respectively for each pumping well data.

iii. The time-drawdown curve of each well was superimposed on the type curve for matching in such a way that the vertical and horizontal axes of both the curves remained parallel.

iv. A "best match point" was obtained and values of W(u), 1/U, d and t for that point were noted. These values are shown in Table 1.

v. By putting the values of W(u), Q and d in the following formula (Theis, 1935), the value of T was obtained:

$$T = \frac{114.6\ Q.W(u)}{d} \qquad (1)$$

where

T = Coefficient of transmissivity (gpd/ft),
Q = Pumping rate (gpm),
W(u) = Well function of "U", and
d = Drawdown (ft).

vi. The value of storage coefficient (S) was found as:

$$S = \frac{U.T.t.}{1.87\ r^2} \qquad (2)$$

where

S = Storage coefficient,
T = Transmissivity,
t = Pumping time (days), and
r = Distance of centres of observation well and pumping well (ft)

The values of r, Q, T and S are tabulated in Table 2.

RESULTS AND DISCUSSION

The data for fifteen pumping wells were analysed. From which the time-drawdown data of four were found not to follow the trend of "Type Curve" and could not be matched with it (a necessary condition of Theis method), and hence were discarded. The data of remaining pumping wells were used for the determination of T & S, as shown in Tables 1 and 2. Table 2 shows variations in the aquifer thickness, soil texture and chemical properties of the aquifer from one locality to another. Another reason could be that the pumping wells might have been partially penetrating-wells. Power breakdown for a considerable period have affected the drawdown resulting in variation of T & S.

Table 1. Best matching point parameters obtained from superimposed time-drawdown and type curve graphs

Pumping well No.	Time (days)	Drawdown (ft)	W(u)	1/U	U
1	0.0694	1.32	4.03	100	0.01
2	0.5000	1.07	4.03	100	0.01
3	0.4167	1.54	4.03	100	0.01
4	0.3333	0.55	4.03	100	0.01
5	0.2083	0.60	4.03	100	0.01

Table 2. Results obtained from the analysis of pumping well test data

Pumping well No.	r (ft)	Q (gpm)	T (gpd/ft)	S (-)
1	250.0	1347.0	4.70×10^5	2.79×10^{-3}
2	300.0	1347.0	5.80×10^5	17.20×10^{-3}
3	300.0	1347.0	4.03×10^5	9.90×10^{-3}
4	400.0	749.0	3.76×10^5	4.19×10^{-3}
5	200.0	749.0	3.45×10^5	9.62×10^{-3}

The results of analysis given in Table 2 through equations 1 & 2 revealed that Theis method took into account not only the effect of pumping time on well yield but also the drawdown could be predicted at any time after pumping had been started. Another remarkable point is that the T & S can be predicted at any time after pumping has started rather than to wait for the equilibrium condition. For this technique, only a single observation well was required which is a salient feature of it.

CONCLUSIONS

Based upon the analysis of data as discussed earlier it was concluded that Theis method was a better technique for the determination of T & S due to its simplicity and predictability in the field studies especially when the pumping wells are fully penetrating.

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