THEIS'S RECOVERY METHOD

After pumping has been shut down the water level will stop dropping and instead rise again to its original position, this being the so-called recovery of the well. The rise of the water level can be measured as residual drawdown s", i.e. as the difference between the orignal water level prior to pumping and the actual water level measured at a certain moment t" since pumping stopped (Fig.1).

The data obtained during recovery permit the calculation of the transmissivity, thus giving a check on the results of the analysis of the data obtained during the pumping period. Moreover the recovery method has the advantage that the rate of recharge Q is constant and equal to the mean rate of discharge Q during pumping. This means that drawdown variations resulting from slight differences in the rate of discharge pumping do not occur during recovery.

The Theis recovery method can be used to calculate the hydraulic properties of an aquifer if the following assumptions and conditions of the Theis method are satisfied:

- The aquifer has a seemingly infinite areal extent;
- The aquifer is homogeneous, isotropic and of uniform thickness over the area influenced by the pumping test;
- Prior to pumping, the piezometric surface and/or phreatic surface are(nearly) horizontal over the area influenced by the pumping test;
- The aquifer is pumped at a constant discharge rate;
- The pumped well penetrates the entire aquifer and thus receives water from the entire thickness of the aquifer by horizontal flow;
- The aquifer is confined;
- The flow to the well is in unsteady state, i.e. the drawdown differences with time are not negligible nor is the hydraulic gradient constant with time;
- The water removed from storage is discharged instantaneously with decline of head;
- The diameter of the pumped well is very small, i.e. the storage in the well can be neglected.

The residual drawdown, s", during the recovery period is, according to THEIS(1935), given by

$$s'' = \frac{Q}{4\pi kD} \left(\ln \frac{4kDt}{r^2S} - \ln \frac{4kDt''}{r^2S''}\right) \qquad (1)$$

Lecture delivered by Dr.G.C.Mishra, Scientist, NIH.

where

s''	= residual drawdown in m;
r	= distance in m from pumped well to observation well or, if the pumped well itself is considered, $r = r_w$ = effective radius of the pumped well;
S''	= coefficient of storage during recovery, dimensionless;
S	= coefficient of storage during pumping, dimensionless;
t	= time in days since pumping started;
t''	= time in days since pumping stopped;
Q	= rate of recharge = rate of discharge in m^3/day.

Procedure

When S and S" are constant and equal, and $u = r^2S/(4kDt'')$ is sufficiently small, Eq.(1) can also be written as

$$s'' = \frac{2.30Q}{4\pi kD} \log \frac{t}{t''} \qquad (2)$$

For one of the piezometers or for the pumped well, s" is plotted versus t/t" on single logarithmic paper (t/t" on logarithmic scale) and a straight line is fitted through the plotted points (Fig. 1) The slope of the line is equal to $2.30Q/(4\pi kD)$; hence the value of $\Delta s''$, the residual drawdown difference per log cycle of t/t", can be read from the graph and substituted into Eq.(3).

$$kD = \frac{2.30Q}{4\pi \Delta s''} \qquad (3)$$

Remarks

- No value for S can be obtained with this method
- When S and S" are constant but unequal the straight line through the plotted points intercepts the time axis where $s'' = 0$ at a point $t/t'' = (t/t'')_o$. At this point Eq.(1) becomes

$$0 = \frac{2.30Q}{4\pi kD}\left(\log\left(\frac{t}{t''}\right)_o - \log \frac{S}{S''}\right)$$

Because $\frac{2.30Q}{4\pi kD} \neq 0$ it follows that $\log(t/t'')_o - \log(S/S'') = 0$,

hence $(t/t'')_o = S/S''$

which determines the relative change of S.

<u>REFERENCE</u>

G.P. Kruseman and N.A.De Ridder, 'Analysis and Evaluation of Pumping Test Data', Bulletin 11, IILRI.

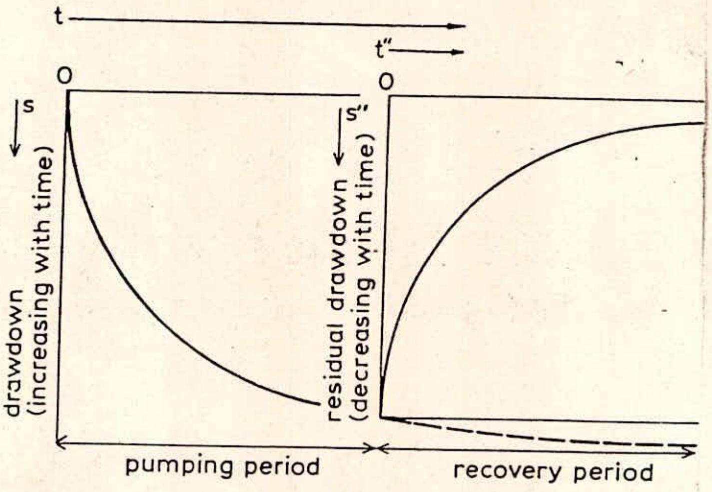

Fig.1 Schematic time-drawdown/residual-drawdown diagram

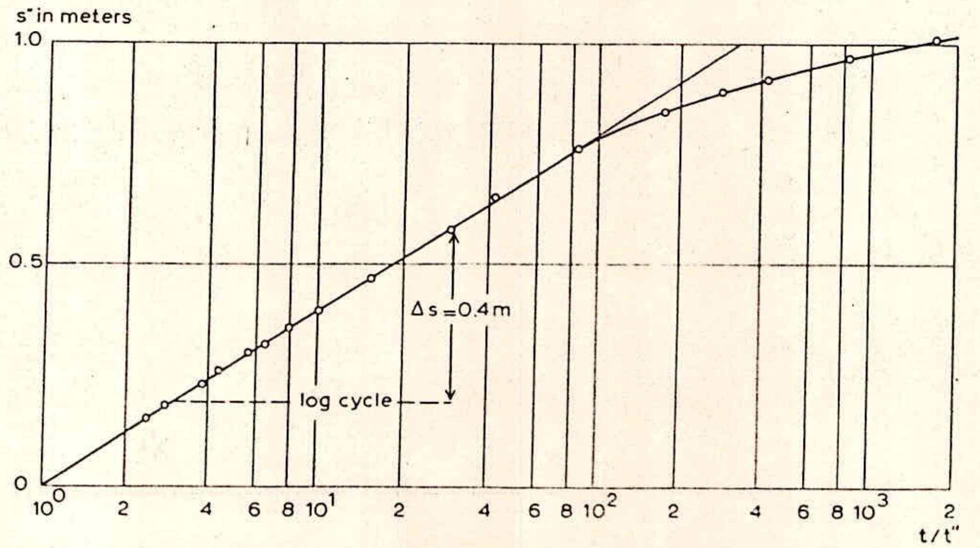

Fig . 2 Analysis of synthetic recovery data from pumping test 'Oude Korendijk. (r = 30 m) with the Theis recovery method